Ershi Qi
Jiang Shen
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Management System Innovation

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Editors
Ershi Qi
Jiang Shen
Industrial Engineering Institution of CME
Tianjin
People's Republic of China

Runliang Dou
College of Management and Economics
Tianjin University
Tianjin
People's Republic of China

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Chapter 1
Research on Self-Organization Evolution Mechanism of Knowledge Capital in High-Tech Virtual Industry Cluster

Chang-yuan Gao and Xiao-yan He

Abstract The main purpose of this paper is to find a way to develop high-tech virtual industry cluster (HTVIC). Considering HTVIC knowledge capital (HKC) as the order parameter, the paper establishes a self-organization model for HKC and analyzes its evolution rules based on potential function by self-organization theory. Lastly, the research draws a conclusion that HKC is a self-organization system and evolves from a disordered state to an ordered state, and even to a more orderly state to realize transition. Therefore, the institution regulation should be set up to reinforce the evolutionary order of HKC, so as to promote the development of HTVIC.

Keywords HKC · HTVIC · Potential function · Self-organization

1.1 Introduction

High-tech industry cluster which is often in the form of high-tech park in practice in China, has become an important factor to promote regional economic development. However, lack of contact and innovation (YuJiang 2008), lock-in effect (Wang and Yan 2009) and other issues have become obstacles for the further development. Virtual industry cluster (Molina and Ponguta 1997) is a cross-

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C. Gao (✉) · X. He
Management department, Harbin University of Science and Technology, Harbin, China
e-mail: hxywaterlily@126.com

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organizational form of cooperation which is proposed in recent years. Virtual means the clusters is no longer subject to geographical restrictions, that is to say, the members will compete and cooperate in the way of organization adjacency. Moreover, Intelligent Platform will be the main contact way instead of usual information technology and network. A recent study shows that it is beneficial to give full play to the advantages of industrial clusters by the way of virtual, and overcome the side effects caused by geographic concentration (Nicolai 1996). Therefore, the development of high-tech virtual industry cluster (HTVIC) can solve above-mentioned problems of high-tech industry cluster, and promote its sustained, healthy and rapid development.

HTVIC is a loose organization (Gao and Du 2010) for the purpose of providing high technology products and services, which is composed of high-tech enterprises, research institutes, intermediaries and government from different geographic regions. As knowledge capital has been the dominant factor to create value, the research on evolution mechanism of KC in HTVIC will contribute to capture the overall variation of HTVIC, and will have a great guiding significance for the theory and practice.

The present study rarely combines HTVIC with knowledge capital, existing research on Multi-agent knowledge capital is in two major ways: Anssi and Marja (2007), Pirjo (2008), Wang and Chen (2010) and Wang et al. (2009) study the subject from a regional perspective; Li (2011) from the angle of alliance. But current research mainly emphasizes the value contribution of knowledge capital to regional and union, ignoring the interaction of the Multi-agent knowledge capital.

Self-organization theory, particular Synergetics, reveals that how elements interact to form the order parameter, and then form ordered structure of system under certain external conditions. HTVIC is more a spontaneous formation of members to adapt to the external environment. In this process, a large of members interacts on each other to form goodwill, brand, the organizational system and other knowledge capital of cluster, and continuously implement value-creating function. Obviously, the appreciation of HTVIC knowledge capital (HKC) is the result from self-organization motion of the subsystem. The self-organization is the essential character, so the paper can preferably reveal the appreciation of HTVIC knowledge capital from the point of view of the interaction between multi-agent knowledge capitals with self-organization theory.

The paper, firstly, defines the concept of HKC, and then analyzes four-dimensional structure of it. Secondly, the paper elaborates the self-organization characteristics and establishes the self-organization equation. Thirdly, the ordered parameter is recognized, and the paper proclaims the self-organization evolution mechanism of HKC on the basis of potential function. The purpose of this paper is to grasp the evolution law of HKC on the whole, and through the realization of HKC appreciation to finally promote the development of HTVIC.

1.2 The Dimensional Structure of HKC

Knowledge capital is pointed out for the first time in 1969 by Galbraith. Later, some of scholars such as Stweart (1994), Edvinsson and Sullivan (1996), Sveiby (1997), Feng et al. (2006), Li (2011) did research on this.

HTVIC is a loose organization which means it is across the organization boundary, and it can be argued that HTVIC also has knowledge capital. There are two levers: cluster lever (HTVIC knowledge capital) and member lever(member knowledge capital). Members knowledge capital (MKC) is like enterprise knowledge capital, so this article does not make the research on it. HTVIC knowledge capital (HKC) is the general name of knowledge elements and ability which can create value for HTVIC, reflecting collective intelligence in the competition and cooperation of all the members, made up of three elements: HTVIC human capital, HTVIC organization capital and HTVIC relationship capital. That is to say, MKC interact with each other and assemble in the virtual space to form HKC.

HKC is the product of self-organization coming from the members' mutual collaboration in the form of elements. Meanwhile, it may possess overall capabilities that the members don't own to create value so that the value-creation by it is greater than total value-creation by members. From the view of the members, the dimensional structure of HKC can be expressed as:

HKC = F (high technology enterprise knowledge capital, research institutes knowledge capital, intermediaries knowledge capital, government knowledge capital).

F means the interaction between MKC and the centralization process, four dimensions means four kinds of member. In each dimension, human capital is the initiative of the value creation, while organization capital and relationship capital guarantee the role of human capital. The three key elements interact with each other to make each member has the following value-added function.

1.3 Self-Organization Model

The formation of HKC is the response of the members to external environment for the purpose of the increment in value. In the process, the interaction of MKC formed ordered structure, function and behavior, which is indeed a self-organized process, with dissipation structure characteristics.

Different MKC can be viewed as the subsystem, the interaction between subsystems can bring about the value-creation. S indicates the state variable HKC, E, R, I and A respectively indicates the state variables of each dimension. Using self organization Dynamics equations, the dimensional structure of HKC can be expressed as the following:

$$dS/dt = -kS + \beta(E, R, I, A) + G \tag{1.1}$$

Make random external force $G = g \cdot S$, g represents the control parameters to promote the evolution of the system, $-\beta S^3$ represents the interaction between subsystems (four dimensions), Eq. (1.1) can be written as:

$$dS/dt = (-k + g)S - \beta S^3 \tag{1.2}$$

Above equations show the evolution process of HKC with time. The original state k, random outside force g and the mutual relationship between subsystems are the key factors to the formation and evolution of HKC.

In self-organization theory, the potential function is used to study the structure, performance and evolution behavior of the system. If there is a function V(x), when $V'(x) = -dx/dt$, $V(x)$ is the potential function of the dynamics equations (JianXiong and Wang 2008). Combined with (1.2), then

$$V'(S) = -dS/dt = -(-k + g)S + \beta S^3 \tag{1.3}$$

Integrating the Eq. (1.3) on both ends, we can get the following potential function.

$$V(S) = -(-k + g)\frac{1}{2}S^2 + \frac{\beta}{4}S^4 \tag{1.4}$$

Minimum value of $V(S)$ is the stability point, which shows the system is in stable state, including disorder and low-level order. Maximum of $V(S)$ is unstable state which forebodes new state, containing evolution and degradation.

1.4 Self-Organization Evolution Mechanism

1.4.1 The Order Parameter Characteristics of HKC

According to synergetics, the order parameter is the product of coordination and competition which measures the macro state of the system Cyrille and Gerard (2009). When HTVIC is not formed, the enterprise and relevant organizations in different regions will realize appreciation independently. At this time, HKC is equal to zero. After the HTVIC is formed, MKC cooperate with each other in the form of elements to shape HKC. Due to the influence of the external environment, the subsystems conduct the cooperative movement under the control of HKC for the aim of realizing the maximization of value-creation. That means the orderly structure is generated. HKC is a macro parameter to describe HTVIC, generating from scratch, and indicating the formation of new structures through Slaving Principle. So, it is in line with the order parameter characteristics, and HKC is indeed the order parameter. In synergetics, the order parameter determines the development direction of the system. When HKC is in the positive evolution direction, HTVIC will evolve. On the contrary, it will degenerate.

1.4.2 The Evolution Mechanism Based on Potential Function

According to the curve determined by Eq. (1.4), there are the following two kinds of situations in the evolution which are shown in Fig. 1.1:

When $(-k+g)<0$, HKC is like a particle in curve I which always shocks near the stable point of the potential function. This shows that the potential energy is weak and the synergy between subsystems is poorer. So HKC does not perform the function of order parameter, and can't development the new structure.

When $(-k+g)>0$, there appears two extreme value point of potential function as V (S1) and V (S2), and two energy valley in two sides of the balance point, such as the curve III. Under the random external force and synergistic effect of subsystems, the particle will appear on any extreme points at the same probability. This shows that there are two states to choose. At this time, the potential energy is stronger and the synergy between subsystems becomes more powerful. HKC play the role of order parameter to promote the system to new orderly structure, and in turn control the behavior of subsystems.

When $(-k+g)$ is from negative to positive, the curves of potential function experience the change of I -II -III, which explains the change of systems status. In critical condition, due to outside fluctuation force and synergistic effect, the state changes from curvet curve III, and the stable point changes from (S0, 0) into (S1, V (S1)) and (S2, V (S2)). That indicates there is more than one possible evolution state. When outside force or the size or rate of HKC is determined, only one way can be selected. Namely, symmetry is broken after non-equilibrium phase transition. That means the orderly structure of system is turned up.

The equilibrium position S can be described as function $(-k+g)$ as shown in Fig. 1.2. When $(-k+g)<0$, there is a stable solution (S0, 0) which shows the

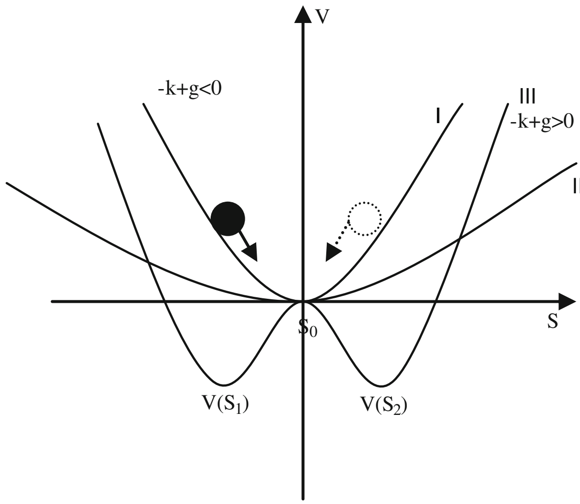

Fig. 1.1 Potential function *curve*

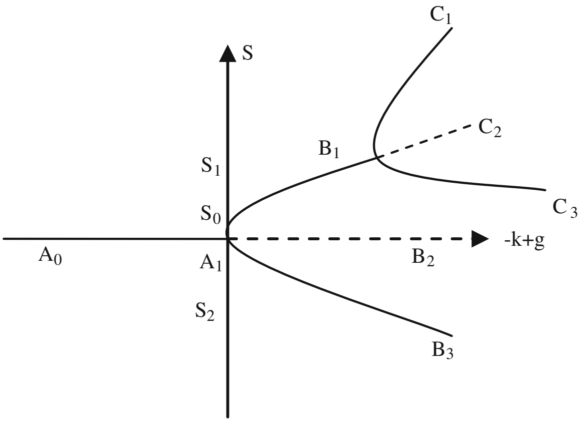

Fig. 1.2 $S \sim -k + g$ function

system is in a steady state; When $(-k + g) > 0$, the original stable solution change into (S1, v (S1)) and (S2, v (S2)), which says the bifurcate appears. A1 is bifurcation point, and A0-A1 is non-equilibrium linear regions. At this moment, the change trend of the system gets enhancement. A1-B2 means unstable nonlinear relationship which shows there are two evolution directions of the system, including A1-B1 branch and A1-B3 branch, determined by the change of the size or rate of HKC. When it is in any branch, due to another change of external environment or the size or the rate of HKC, new fluctuation and new bifurcation point turn up, which forms the leap development of the system.

1.5 Conclusion

HKC is the order parameter, the evolution of which determines the status of HTVIC system. So, it is necessary to start from HKC for the development of HTVIC. According to self-organization theory, taking HKC as a self-organization system, the paper establishes self-organization model to reveal the key effective factors on its evolution, and then reveals the transition evolution law that HKC evolves from disordered state to ordered state, and even to the further orderly state based on potential function.

Therefore, in practice, the external conditions should be constantly improved to make HTVIC to achieve critical state and produce order parameter (HKC). Simultaneously, the external institution regulation should be established to foster expected HKC. When HKC can control the independent movement of the subsystems, under the guidance of HKC, HTVIC will achieve its orderly structure, namely the value-added. As HKC is formed upon self-organization motion, the external institution regulation should be in line with the evolution law rather than function as outside force, aiming to promote the rapid formation of HKC and better play the role of order parameter.

Meanwhile, because there are a variety of options for the evolution directions of HKC on request of different value added, the establishment of institution regulation can enhance HKC and push forward positive evolutionary order of HKC, which in order to promote the healthy development of the HTVIC. When the trend of degenerated order appears, we should take measures to prevent the emergence of the critical point to keep continuous development of HTVIC, or we should induce the emergence of new order parameter to drive the transition of the system. inally, you are responsible for language as editors will not check it. Do a spell and grammar check. This is available in Word. If English is not your native language, get a professional proof-reader to help if possible.

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Chapter 2
A Fuzzy Multi-Attribute Decision-Making Method for Partner Selection of Cooperation Innovation Alliance

Dan Li

Abstract The technological cooperation activities among enterprises, universities and research institutes are considered be necessary for accessing complementary technological resources and improving the technology innovation capability. One of the important approaches to cooperation is constructing cooperation innovation alliance. But cooperation innovation alliances are risky. How to choose the right partners and improve the efficiency of cooperation innovation is the question many enterprises concerned with. So the decision-making model of partner selection in cooperation innovation alliance is proposed in this paper, and an index system is set up. It is a fuzzy multiple attribute decision-making problems. And then a fuzzy multiple index decision-making method basing on TOPSIS is proposed. Finally, an example is shown in detail.

Keywords Cooperation innovation · Multi-attribute decision making · Partners selection · TOPSIS · Triangular fuzzy number

2.1 Introduction

With the rapid development of information technology, enterprises need to improve the technology innovation capability and sustain knowledge competitive advantage. But it is difficult for an enterprise to master all of the knowledge required and to realize technological innovation independently because there is a lack of resources, technology, skills or finances. It leads enterprises to search

D. Li (✉)
Business School, East China University of Political Science and Law,
Shanghai, China
e-mail: huazhengld@126.com

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beyond their own boundaries for valuable resource (Becker and Dietz 2004). So many enterprises cooperate with each other, and the cooperation activities with other organizations and share knowledge are considered be an opportunity to access technological resources required. It can contribute to faster development of innovations, improved market access, economies of scale and scope, cost sharing and risk spreading (Pedro de Faria 2010).

One of the important approaches to cooperation is constructing cooperation innovation alliance. As the knowledge alliance, strategic cooperation innovation alliance refers to that an enterprise selects external cooperative partners to construct a cooperation alliance to learn each other, and share and acquire knowledge resource and advanced technology in order to create knowledge and technological products, enhance knowledge innovation capability and sustain the knowledge competitive advantage. But cooperation innovation alliances are risky. They are dangerous ventures that can harm unwary participants (Brouthers et al. 1995). And the ratio of failure for technological innovation alliance gets to 50–60 % (Rackham and Rackham 1995). Lots of alliance failures attribute to lacking of professional ability of partners selection including index system and methods methods (Lorange and Roos 1992).

In the process of cooperation innovation, enterprises are the main body of knowledge and technological innovation. The core enterprise need select the most correct cooperative partners, including kinds of enterprises, universities, research institutes and so on. So from the view of enterprises, this paper tries to propose a method to select partners of strategic cooperation innovation alliance that can be used to help enterprises conduct such assessment and make the right choice. In this paper, a framework of decision-making model is proposed and an index system of partner selection for cooperation innovation alliance is set up, and then a fuzzy decision-making method basing on TOPSIS is proposed considering the subjectivity and fuzziness of the indexes.

2.2 The Fuzzy Multi-Attribute Decision-Making Model and the Criteria of Partners Selection

2.2.1 The Framework of Decision-Making Model

In this paper, a framework model of decision-making is proposed (shown in Fig. 2.1). The implement steps and the model for partner selection of cooperation innovation alliance are described in the framework. First, we need find out the influencing factors for the implement of knowledge cooperation strategy and set up the criteria system of partner selection. Then the fuzzy weight and fuzzy assessed value is obtained according to the linguistic variable and triangular fuzzy number. At last, we adopt the TOPSIS method to obtain the ranking order of partners.

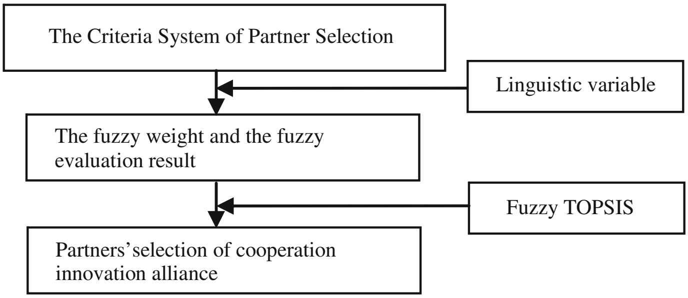

Fig. 2.1 The model framework of partner selection

2.2.2 *Establishment of the Multilayer Hierarchical Structure for Decision-Makings*

The four key characteristic of strategic alliances are point out by Brouthersas, including complementary skills, cooperative cultures, the compatible goals, and the commensurate levels of risk (Brouthers et al. 1995). It is necessary for enterprises to select partners according to the technology level, the state of the knowledge innovation activities and the running environment which have the potential to impact strategic cooperation innovation process and the technology cooperation goal. So it can be considered that the partner selection of cooperation innovation should adopt a comprehensive index in this paper. We adopt five indices, including the measurement from the aspect of compatibility as well the aspect of the property rights and reputation, technology resource capacity, R&D capacity and management capacity (Wang and Zhou 2008; Yang et al. 2009; Li 2008).

The hierarchical structure for partner selection of cooperation innovation alliance is shown as Table 2.1.

2.3 The Decision-Making Method Basing on the Topsis

During the process of partners' selection, we assume that $A = \{A_1, A_2, \ldots, A_n\}$ is a set of all alternatives. And form a committee of assessment experts and identify the decision-making criteria. $I = \{I_1, I_2, \ldots, I_n\}$ is a set of given evaluation index. The adopted evaluation information includes index weight vector $\tilde{w} = (\tilde{w}_1, \tilde{w}_2, \ldots, \tilde{w}_n)^T$ and fuzzy evaluation matrixes $\tilde{X} = [\tilde{x}_{ij}]_{m \times n}$. The importance weights of each criteria and the linguistic rating can be considered as linguistic variables.

Triangular fuzzy numbers can be used to represent these linguistic variables as Table 2.2.

Table 2.1 A criteria system for partner selection of cooperation innovation alliance

Evaluating index	Concrete evaluating index
Compatibility (I_1)	Organization culture (I_{11})
	Cooperative target (I_{12})
Property rights and reputation (I_2)	The degrees of reputation (I_{21})
	Cooperation experience (I_{22})
	Intellectual property standards (I_{23})
Technology resource capacity (I_3)	The level of knowledge resource and knowledge workers (I_{31})
	The intelligence and standardization of information management system (I_{32})
R&D capacity (I_4)	Technology innovation capacity (I_{41})
	The advancement building of Technology (I_{42})
	Complementarities of technology (I_{43})
Management capacity (I_5)	Risk management capacity (I_{51})
	Communication and coordination capacity (I_{52})

Assume $\tilde{x}_{ij} = (\rho_{ij}, \pi_{ij,}\sigma_{ij})$ is the targeted value of criterion I_j for alternative A_i in triangular fuzzy numbers. Assume that a decision-making group has K persons, $\tilde{w}_j^{\mu}$ is the fuzzy weight for I_j given by evaluators M_{μ} $(\mu = 1, 2, \ldots K)$. $\tilde{x}_{ij}^{\mu}$ is the fuzzy assessed value for I_j of A_i. Calculate the importance of the criteria and the rating of alternatives by formula (2.1) and (2.2):

$$\tilde{w}_j = \frac{1}{K}(\tilde{w}_j^1 + \tilde{w}_j^2 + \cdots + \tilde{w}_j^K) \tag{2.1}$$

$$\tilde{x}_{ij} = \frac{1}{K}(\tilde{x}_{ij}^1 + \tilde{x}_{ij}^2 + \cdots + \tilde{x}_{ij}^K) \tag{2.2}$$

The multi-person multi-criteria decision-making method basing on TOPSIS can be express in the following (Chen 2000; Tang et al. 2008).

Table 2.2 Linguistic variables for the importance weight of each criterion and the ratings

Linguistic variables of weight	Linguistic variables of index	Corresponding triangle fuzzy numbers
Very low (VL)	Very bad (VB)	(0,0,0.1)
Low (L)	Bad (B)	(0,0.1,0.3)
Medium low (ML)	Worse than middling (WM)	(0.1,0.3,0.5)
Middling (M)	Middling (M)	(0.3,0.5,0.7)
Medium high (MH)	Better than middling (BM)	(0.5,0.7,0.9)
High (H)	Good (G)	(0.7,0.9,1.0)
Very high (VH)	Very good (VG)	(0.9,1.0,1.0)

1. *Construct the normalized fuzzy decision matrix*

According to the fuzzy TOPSIS method, it is necessary to use the linear scale transformation to transform the various criteria scales into a comparable scale. B is the set of benefit criteria, and D is the set of cost criteria, that is

$$\bar{x}_{ij} = (\frac{\rho_{ij}}{\sigma_j^*}, \frac{\pi_{ij}}{\sigma_j^*}, \frac{\sigma_{ij}}{\sigma_j^*}),\ j \in B \tag{2.3}$$

$$\bar{x}_{ij} = (\frac{\rho_j^-}{\rho_{ij}}, \frac{\rho_j^-}{\pi_{ij}}, \frac{\rho_j^-}{\sigma_{ij}}),\ j \in D \tag{2.4}$$

$$\sigma_j^* = \max_i\{\sigma_{ij}\},\ \rho_{\overline{ij}} = \min_i\{\rho_{ij}\} \tag{2.5}$$

Then the ranges of normalized triangular fuzzy numbers belong to $[0, 1]$ can be guaranteed by using this method.

2. *Construct the weighted normalized fuzzy decision matrix*

The weighted normalized fuzzy decision matrix can be constructed as:

$$V = (v_{ij})_{m \times n} = \left(\tilde{w}_j \bar{x}_{ij}\right)_{m \times n} \tag{2.6}$$

3. *Determine the positive ideal alternative S^* and the negative ideal alternative S^-*

The fuzzy positive-ideal solution (FPIS, S^*) can be defined as

$$S^* = \left(v_1^*, v_2^*, \ldots v_n^*\right) \tag{2.7}$$

The fuzzy negative-ideal solution (FNIS, S^-) can be defined as

$$S^- = \left(v_1^-, v_2^-, \ldots v_n^-\right) \tag{2.8}$$

Where $v_j^* = (1, 1, 1)$ and $v_j^- = (0, 0, 0)$, $j = 1, 2, \ldots n$.

4. *Calculate the distance of each alternative from S^* and S^-*

Definition 1. Let $\alpha = (\alpha_1, \alpha_2, \alpha_3)$ and $\beta = (\beta_1, \beta_2, \beta_3)$ be two triangular fuzzy numbers, the distance between them can be calculate as

$$d(\alpha, \beta) = \sqrt{\frac{(\alpha_1 - \beta_1) + (\alpha_2 - \beta_2) + (\alpha_3 - \beta_3)}{3}} \tag{2.9}$$

According to the definition 1, calculate the distance of each alternative from S^* and S^- by using formula (2.10) and (2.11):

$$d_i^* = \sum_{j=1}^{n} d\left(v_{ij}, v_j^*\right), \; i = 1, 2, \ldots m \tag{2.10}$$

$$d_i^- = \sum_{j=1}^{n} d\left(v_{ij}, v_j^-\right), \; i = 1, 2, \ldots m \tag{2.11}$$

5. *Calculate the closeness coefficient and Determine the ranking order*

The closeness coefficient of each alternative is calculated as

$$CC_i = \frac{d_i^-}{d_i^* + d_i^-} \tag{2.12}$$

The ranking order of all alternatives can be determined by calculating the closeness coefficient. The alternative is closer to the FPIS (S^*) and father form FNIS (S^-) as CC_i approaches to 1. Therefore, we can know who the best alternative is.

2.4 Illustrative Example

Suppose there are three enterprises,A_1, A_2 and A_3 need to be selected as one partner of cooperation innovation alliance. Four evaluators M_1, M_2, M_3 and M_4 have been invited.

The importance weight and fuzzy weights of the criteria are assessed by evaluators as following as Table 2.3.

Table 2.3 The importance weight and fuzzy weights of the criteria

Criteria	Evaluators				Fuzzy weights
	M_1	M_2	M_3	M_4	
I_{11}	MH	ML	H	M	(0.4,0.6,0.78)
I_{12}	M	MH	M	H	(0.45,0.65,0.83)
I_{21}	H	VH	MH	H	(0.7,0.88,0.98)
I_{22}	H	MH	VH	M	(0.6,0.78,0.9)
I_{23}	ML	M	M	MH	(0.3,0.5,0.7)
I_{31}	H	M	ML	M	(0.35,0.55,0.73)
I_{32}	M	VH	H	H	(0.65,0.83,0.93)
I_{41}	VH	H	MH	ML	(0.55,0.73,0.85)
I_{42}	H	VH	M	MH	(0.6,0.78,0.9)
I_{43}	H	H	MH	M	(0.55,0.75,0.9)
I_{51}	MH	ML	H	VH	(0.55,0.73,0.85)
I_{52}	M	MH	M	VH	(0.5,0.68,0.83)

The linguistic rating variable (shown in Table 2.2) is used to evaluate the rating of alternatives. The normalized attribute value and the weighted normalized attribute value are constructed as Table 2.4.

Calculate the distance of alternative from the positive ideal alternative and the negative ideal alternative as Table 2.5.

Table 2.4 The weighted normalized attribute value of three alternatives by evaluators under all criteria

Criteria	Candidates	Evaluators				Fuzzy attribute value	Normalized attribute value	Weighted normalized attribute value
		M_1	M_2	M_3	M_4			
I_{11}	A_1	G	M	VG	M	(0.55,0.73,0.85)	(0.59,0.78,0.91)	(0.24,0.47,0.71)
	A_2	VG	BM	G	M	(0.60,0.78,0.90)	(0.65,0.84,0.97)	(0.26,0.50,0.76)
	A_3	M	VG	G	G	(0.65,0.83,0.93)	(0.70,0.89,1)	(0.28,0.53,0.78)
I_{12}	A_1	G	G	VG	BM	(0.70,0.88,0.98)	(0.71,0.90,1)	(0.32,0.59,0.83)
	A_2	M	WM	BM	G	(0.40,0.60,0.78)	(0.41,0.61,0.80)	(0.18,0.40,0.66)
	A_3	BM	M	G	G	(0.55,0.75,0.90)	(0.56,0.77,0.92)	(0.25,0.50,0.76)
I_{21}	A_1	M	G	BM	BM	(0.50,0.70,0.88)	(0.56,0.78,0.98)	(0.39,0.69,0.96)
	A_2	G	BM	M	G	(0.55,0.75,0.90)	(0.61,0.83,1)	(0.43,0.73,0.98)
	A_3	BM	M	WM	M	(0.30,0.50,0.70)	(0.33,0.56,0.78)	(0.23,0.49,0.76)
I_{22}	A_1	G	BM	M	G	(0.55,0.75,0.90)	(0.56,0.77,0.92)	(0.34,0.60,0.83)
	A_2	VG	VG	BM	G	(0.75,0.90,0.98)	(0.77,0.92,1)	(0.46,0.72,0.90)
	A_3	BM	VG	G	M	(0.60,0.78,0.90)	(0.61,0.80,0.92)	(0.37,0.62,0.83)
I_{23}	A_1	G	BM	BM	M	(0.50,0.70,0.88)	(0.54,0.75,0.95)	(0.16,0.38,0.67)
	A_2	M	G	WM	BM	(0.40,0.60,0.78)	(0.43,0.65,0.84)	(0.13,0.33,0.59)
	A_3	M	VG	VG	G	(0.70,0.85,0.93)	(0.75,0.91,1)	(0.23,0.46,0.70)
I_{31}	A_1	VG	WM	G	M	(0.50,0.68,0.80)	(0.56,0.76,0.89)	(0.20,0.42,0.65)
	A_2	BM	G	M	G	(0.55,0.75,0.90)	(0.61,0.83,1)	(0.21,0.46,0.73)
	A_3	G	VG	BM	M	(0.60,0.78,0.90)	(0.67,0.87,1)	(0.23,0.48,0.73)
I_{32}	A_1	BM	G	VG	G	(0.70,0.88,0.98)	(0.71,0.90,1)	(0.46,0.75,0.93)
	A_2	M	BM	G	VG	(0.60,0.78,0.90)	(0.61,0.80,0.92)	(0.40,0.66,0.86)
	A_3	BM	WM	G	VG	(0.55,0.73,0.85)	(0.56,0.74,0.87)	(0.36,0.61,0.81)
I_{41}	A_1	VG	G	G	BM	(0.70,0.88,0.98)	(0.71,0.90,1)	(0.39,0.66,0.85)
	A_2	M	M	BM	G	(0.45,0.65,0.83)	(0.46,0.66,0.85)	(0.25,0.48,0.72)
	A_3	M	G	VG	G	(0.65,0.83,0.93)	(0.66,0.85,0.95)	(0.36,0.62,0.81)
I_{42}	A_1	BM	M	BM	G	(0.50,0.70,0.88)	(0.51,0.71,0.90)	(0.34,0.55,0.81)
	A_2	VG	G	M	WM	(0.50,0.68,0.80)	(0.51,0.69,0.82)	(0.31,0.54,0.74)
	A_3	G	BM	G	VG	(0.70,0.88,0.98)	(0.71,0.90,1)	(0.43,0.70,0.90)
I_{43}	A_1	M	G	G	VG	(0.65,0.83,0.93)	(0.70,0.89,1)	(0.39,0.67,0.90)
	A_2	G	M	G	VG	(0.65,0.83,0.93)	(0.70,0.89,1)	(0.39,0.67,0.90)
	A_3	WM	BM	M	G	(0.40,0.60,0.78)	(0.43,0.65,0.84)	(0.24,0.49,0.76)
I_{51}	A_1	G	G	M	BM	(0.55,0.75,0.90)	(0.56,0.77,0.92)	(0.31,0.56,0.78)
	A_2	M	G	BM	M	(0.45,0.65,0.83)	(0.46,0.66,0.85)	(0.25,0.48,0.72)
	A_3	G	BM	VG	G	(0.70,0.88,0.98)	(0.71,0.90,1)	(0.39,0.66,0.85)
I_{52}	A_1	BM	G	VG	M	(0.60,0.78,0.90)	(0.60,0.78,0.90)	(0.30,0.53,0.75)
	A_2	G	VG	G	G	(0.75,0.93,1)	(0.75,0.93,1)	(0.38,0.63,0.83)
	A_3	M	G	BM	M	(0.45,0.65,0.83)	(0.45,0.65,0.83)	(0.23,0.44,0.69)

Table 2.5 The distance measurement

	s^*	s^-
A_1	5.7527	6.9612
A_2	5.8133	6.97
A_3	5.9693	6.9506

And calculate the closeness coefficient of each organization as $\mathrm{CC}_1 = 0.5475$, $\mathrm{CC}_2 = 0.5452$, $\mathrm{CC}_3 = 0.5380$. The ranking order of organization is A_1, A_2 and A_3. Obviously, A_1 is the most suitable alternative as partner in cooperation innovation alliance.

2.5 Conclusion

Cooperation is considered an important component of innovation process. In this context, cooperation innovation alliance is constructed. Many enterprises, universities and research institutes cooperate in the areas of R&D and innovation. Partners' selection is the important segment of cooperation process. It decides the performance of cooperation innovation alliance. The study is mainly focused on partner selection problem of cooperation innovation alliance. It is a complex and multi-attribute decision-making problem. In this paper an index system of partner selection for cooperation innovation alliance is set up, and a fuzzy decision-making method basing on TOPSIS is proposed. In the future, core enterprise in cooperation innovation alliance should continuously take an in-depth look for the best method for selecting partners and cooperation model that can benefit knowledge cooperation innovation environment as well as knowledge cooperation performance.

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Chapter 3
A Priority Analysis Algorithm for Technology Innovation Risks of Research Solutions for Complex Project

Ning-sheng Guo and Xiansheng Qin

Abstract For complex project, there are many risks about technology innovation according to multifarious research solutions. It is very difficult to analyze the magnitude of these risks of research solutions. This paper purposed a priority analysis algorithm for technology innovation risks (TIR) of research solutions for complex project based on multi-objective and colony-deciding method to choose the research solution by the constraints of multifarious risks. The multi-objective and colony-deciding method is applied to analyze project complexity, technology difficulty, technique capability and so on to obtain multi-TIRs sequence, and the research solution of minimal TIR is optimum. The algorithm is successful to analysis an example which performed quiet well.

Keywords Technology innovation risk (TIR) · Research solution · Priority analysis · Multi-objects · Colony-deciding

3.1 Introduction

For complex project, there are many risks about technology innovation according to multifarious research solutions. It is very difficult to analyze the magnitude of these risks of research solutions. There are two type of risk management: risk analysis and risk quantification. For risk analysis, there are risk analysis based on the triangular fuzzy number and Analytic Hierarchy Process (Zou et al. 2012; Chen et al. 2012), and expert evaluation (Yang et al. 2011; Fallet et al. 2011; Hall 2011). This paper will analysis the multi-objects constrains as project complexity, technology difficulty, technique capability and so on, apply the colony-deciding

N. Guo (✉) · X. Qin
School of Mechanical Engineering, Northwestern Polytechnical University, Xi'an, China
e-mail: guons2012@163.com

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method (Zhang 2008; Quan-lin and Hong 2003) to solve the sequence of TIRs of research solutions, to gain the research solution whose TIR is minimal.

3.2 TIRs' Priority of Research Solutions for Complex Project

The TIRs' priority of multifarious research solutions for complex project based on colony-deciding method was analyzed by $l(l \geq 3)$ experts made up of project managers, research experts, experiment experts, and so on. Under the restrictions of project complexity, technology difficulty and technique capability, the experts define the TIRs' Priority relationship between two research solutions, and perform the deciding process of non-negative priority degree $\beta(\beta \geq 0)$ with the coefficient $w = (w_1, w_2, \ldots w_{n-1})^T$ which means:

$$I_k = \left\{ |(k(t), k'(t))| Tir_{k(t_k)} \succ Tir_{k'(t_k)}, t = 1, 2, \ldots, t_k \right\}.$$

Tir_k is the kth research solution.

Suppose the number of research solutions for a complex project is n, and the research solutions can be performed as $Tir_1, Tir_2, \ldots, Tir_n$; the number of constrain objects is supposed to be m, and the constrain objects can be performed as $P_1, P_2, \ldots, P_m$; (There constrain objects are project complexity, technology difficulty, technique capability, and so on); the number of experts coming from project manager, research and experiment who take part in the decision supposed to be l.

Each TIR according to constrain objects can be performed as matrix T, which means:

$$T = \begin{bmatrix} t_{11} & t_{12} & \ldots & t_{1m} \\ t_{21} & t_{22} & \ldots & t_{2m} \\ \ldots & \ldots & \ldots & \ldots \\ t_{n,1} & t_{n,2} & \ldots & t_{n,m} \end{bmatrix}.$$

t_{ij} stands for the constrain objects P_j of Tir_i, and $0 \leq t_{ij} \leq 1$, $i = 1, 2, \ldots, n$, $j = 1, 2, \ldots, m$.

Purpose that $W \subset E_+^n$ represents the closed convex cone, W represents the important degree of each constrain object. Each expert comes to agree a preference among the attributes. Such as: $W = \left\{ w \subset E_+^n | w_1 \geq w_2 \geq \cdots \geq w_n \geq 0 \right\}$, where $w = (w_1, w_2, \ldots, w_n)^T$.

If $\exists \beta \in E^1$, and

$$(w_1, w_2, \ldots, w_n)^T \in W \cap \left\{ w | e^T w = 1, w \geq 0 \right\}.$$

which made $\sum_{i=1}^{n} w_k a_{ik} \geq \sum_{i=1}^{n} w_k a_{jk} + \beta$, and Tir_i was priority of Tir_j as DIO β, which means $Tir_i \succ Tir_j$, $a_s^r = (a_{r1} - a_{s1}, a_{r2} - a_{s2}, \ldots, a_{rn} - a_{sn})$. Where $1 \leq i, j \leq n$, $i \neq j$, $e = (1, 1, \ldots, 1)^T \in E^n$, and $(r, s) \in \bigcup_{k=1}^{l} I_k$.

We purpose $\bar{\beta} \geq 0$,

$\bar{w} = (\bar{w}_1, \bar{w}_2, \ldots, \bar{w}_{n-1})^T \in W, \; e^T \bar{w} = 1, \bar{w} \geq 0$

which made $a_r^s \bar{w} \geq \bar{\beta}$, $(r, s) \in \bigcup_{k=1}^{l} I_k$. $\bar{w}$ is accordant and $\bar{\beta}$ is the accordant exponent in the TIR.

3.3 Priority Analysis Algorithm of TIRs Based on Multi-Objective and Colony-Deciding Method

The priority analysis algorithm for TIRs based on multi-objective and colony-deciding method can be described as:

(1) The priority relationship of TIRs of the research solution from l experts coming from project manager, research and experiment can be described as:

$$Tir_{k(1)} \succ Tir_{k'(1)}, Tir_{k(2)} \succ Tir_{k'(2)}, \ldots, Tir_{k(t_k)} \succ Tir_{k'(t_k)}, k = 1, 2, \ldots, l$$

Where:

$$k(t), k'(t) \in \{1, 2, \ldots, n\}, k(t) \neq k'(t), t = 1, 2, \ldots, t_k, t_k \geq 1$$

Marked as:

$$I_k = \left\{ |(k(t), k'(t))| Tir_{k(t_k)} \succ Tir_{k'(t_k)}, t = 1, 2, \ldots, t_k \right\}$$
$$a_s^r = (a_{r1} - a_{s1}, a_{r2} - a_{s2}, \ldots, a_{rn} - a_{sn})$$

Where $(r, s) \in \bigcup_{k=1}^{l} I_k$.

(2) for the instants:

$$(P) \begin{cases} \max \beta, \\ a_r^s w \geq \beta, (r, s) \in I_k, \\ e^T w = 1, w \geq 0, w \in W. \end{cases}$$

Purposed the optimal solution is $\left(\hat{w}, \hat{\beta}\right)$, if $\hat{\beta} \geq 0$, then priority relationship made by the experts coming from project manager, research and experiment is harmonious.

$$Tir_r \succ Tir_s, \; (r, s) \in \bigcup_{k=1}^{l} I_k$$

And $\hat{w}$ is the accordant; if $\hat{\beta} < 0$, go to(3).

(3) marked $I_k = \left\{(r,s)|a_s^r\hat{w} = \hat{\beta}, (r,s) \in I_k\right\}$, $k = 1,2,\ldots,l$,$\forall\ (r',s') \in \bigcup_{k=1}^{l} \hat{I}_k$, to solve:

$$\left(P_{s'}^{r'}\right)\begin{cases} \max\ a_{s'}^{r'}\hat{w}, \\ a_r^s w \geq \hat{\beta}, (r,s) \in \hat{I}_k, \\ e^T w = 1, w \geq 0, w \in W. \end{cases}$$

Purpose the optimal solution of $\left(P_{s'}^{r'}\right)$ is: $\hat{w}$, $(r',s') \in \bigcup_{k=1}^{l} \hat{I}_k$.

Marked as

$$\hat{\hat{I}}_k = \left\{(r',s')|a_{s'}^{r'}w_{s'}^{r'} = \hat{\beta}, (r',s') \in \hat{I}_k\right\}, k = 1,2,\ldots,l$$

(4) The experts can modify the priority relationship between the research solutions, according to two instances. (1) giving up the priority relationship $Tir_{r'} \succ Tir_{s'}$; (2) upending the relationship, which means transforming $Tir_{r'} \succ Tir_{s'}$ to $Tir_{s'} \succ Tir_{r'}$.

(5) If the first instance is chosen, all experts decide to give up the priority relationship $Tir_{r'} \succ Tir_{s'}$. Then it was equal to solve $\left(\bar{w}, \bar{\beta}\right)$ as:

$$\left(\hat{P}_1\right)\begin{cases} \max\ \beta, \\ a_r^s w \geq \beta, (r,s) \in \bigcup_{k=1}^{l} I_k \setminus \bigcup_{k=1}^{l} \hat{\hat{I}}_k, \\ e^T w = 1, w \geq 0, w \in W. \end{cases}$$

Otherwise if the second instance is chosen, all experts decide to upend the relationship and to transform $Tir_{r'} \succ Tir_{s'}$ to $Tir_{s'} \succ Tir_{r'}$. Then it was equal to solve $\left(\bar{w}, \bar{\beta}\right)$ as:

$$\left(\hat{P}_2\right)\begin{cases} \max\ \beta, \\ a_r^s w \geq \beta, (r,s) \in \bigcup_{k=1}^{l} I_k \setminus \bigcup_{k=1}^{l} \hat{\hat{I}}_k, \\ a_r^s w \geq \beta, (r,s) \in \bigcup_{k=1}^{l} \hat{\hat{I}}_k, \\ e^T w = 1, w \geq 0, w \in W. \end{cases}$$

(6) If $\bar{\beta} \geq 0$, then $\bar{w}$ was the accordant made by l experts coming from project manager, research and experiment; otherwise if $\bar{\beta} < 0$, repeat(3), until $\bar{\beta} \geq 0$.

3.4 Instance Analysis

We select a project from the National High-Tech R&D Program. There are four research solutions of this project. And the four solutions have their own TIRs: $Tir_1, Tir_2, Tir_3, Tir_4$. For the multi-objects constrains from project complexity, technology difficulty and technique capability, four experts coming from project manager, research and experiment must decide which research solution be selected. And $W \subset E_+^4$. The four experts give the initial relationship between two TIRs as follows:

$$\begin{cases} Expert1: Tir_1 \succ Tir_2, I_{11} = \{(1,2)\}; Tir_4 \succ Tir_3, I_{12} = \{(4,3)\}; \\ Expert2: Tir_1 \succ Tir_2, I_{21} = \{(1,2)\}; Tir_1 \succ Tir_3, I_{22} = \{(1,3)\}; \\ Expert3: Tir_2 \succ Tir_3, I_{31} = \{(2,3)\}; Tir_4 \succ Tir_1, I_{32} = \{(4,1)\}; \\ Expert4: Tir_4 \succ Tir_2, I_{41} = \{(4,2)\}; Tir_1 \succ Tir_2, I_{42} = \{(1,2)\}; \end{cases}$$

And they give decision-coefficients about project complexity, technology difficulty and technique capability as follows:

$$T = \begin{bmatrix} 0.6 & 0.2 & 0.2 \\ 0.6 & 0.1 & 0.3 \\ 0.5 & 0.3 & 0.2 \\ 0.5 & 0.2 & 0.3 \end{bmatrix}$$

After deleting the same initial relationships, we can get the coefficients about initial relationship.

$$\begin{cases} a_2^1 = (a_{11} - a_{21}, a_{12} - a_{22}, a_{13} - a_{23}) = (0, 0.1, -0.1); \\ a_3^4 = (a_{41} - a_{31}, a_{42} - a_{32}, a_{43} - a_{33}) = (0, -0.1, 0.1); \\ a_3^1 = (a_{11} - a_{31}, a_{12} - a_{32}, a_{13} - a_{33}) = (0.1, -0.1, 0); \\ a_3^2 = (a_{21} - a_{31}, a_{22} - a_{32}, a_{23} - a_{33}) = (0.1, -0.2, 0.1); \\ a_1^4 = (a_{41} - a_{11}, a_{42} - a_{12}, a_{43} - a_{13}) = (-0.1, 0, 0.1); \\ a_2^4 = (a_{41} - a_{21}, a_{42} - a_{22}, a_{43} - a_{23}) = (-0.1, 0.1, 0). \end{cases}$$

For Problem (P):

$$(P)\begin{cases} \max\beta; \\ 0.1w_2 - 0.1w_3 \geq \beta; \\ -0.1w_2 + 0.1w_3 \geq \beta; \\ 0.1w_1 - 0.1w_2 \geq \beta; \\ 0.1w_1 - 0.2w_2 + 0.1w_3 \geq \beta; \\ -0.1w_1 + 0.1w_3 \geq \beta; \\ -0.1w_1 + 0.1w_2 \geq \beta; \\ w_1 + w_2 + w_3 = 1; \\ w_1 \geq 0; w_2 \geq 0; w_3 \geq 0. \end{cases}$$

Obtain the optimal values of β, w_1, w_2, w_3 as follows:

$$\hat{\beta} = 0, \hat{w}_1 = \hat{w}_2 = \hat{w}_3 = \frac{1}{3}$$

When $\hat{\beta} \geq 0$, the problem (P) is harmonious. Here $w = (w_1, w_2, w_3)^T = \left(\frac{1}{3}, \frac{1}{3}, \frac{1}{3}\right)^T$.

$$Tir_4 \succ Tir_1 \succ Tir_2 \succ Tir_3$$

We can obtain the sequence of priority relationship as $Tir_4, Tir_1, Tir_2, Tir_3$ of four research solutions. So we think TIR of the third research solution is minimal for this project from the National High-Tech R&D Program.

3.5 Conclusion

This paper presented a priority analysis algorithm for TIRs of research solutions for complex project based on colony-deciding method for multi-objects. We accomplished to decide how to select the minimal TIR of research solution from many research solutions by multi-objects and multi-experts.

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Chapter 4
A Study on Assessment of Human Nature Needs in Human Resource Management

Qiong Zhang, Xiao-mei Wang and Wei-xun Hu

Abstract Different classes of people who live in the society possess their own personality as well as many social commonality points. Therefore, only by grasping the nature of humans can we examine the behavior features of people. Through the analysis of the essence of human nature, this article summarizes the general model of human needs, and takes insight into the maximum need of human nature, then makes effective decisions to achieve the most optimal configuration in the management of human resources.

Keywords Human nature hypothesis · Human resource management · Needs assessment · Need theory

4.1 Introduction

How to conduct successful human resource management? As Drucker said: "Today, renaming the Personnel Department to the Human Resources Department is becoming a trend. But few people realize that it means we need to have more than just one outstanding personnel department. Peter (1954) Human resource is the primary resource, the spirit of talent of enterprise directly affects its human resources circumstance. As a decision maker, to realize a rational allocation of human resources in his management, one should get to know their expertise, moreover, to understand the employees' individual needs is more important for him. Here the need is multifaceted, Lenin said:" bread will be there, love follows."

Q. Zhang (✉) · X. Wang
Department of Basis, Military Economic Academy, Wuhan, China
e-mail: zq0988@gmail.com

W. Hu
Department of Training, Military Economic Academy, Wuhan, China

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This is the easiest way to explain the needs of human nature, one is substance, which is indispensible for the survival of humans, such as: eating, drinking, and living. The other is spirit which includes love, knowledge acquisition, daily entertainment and so on. The continuous development of society makes human nature needs become more complex and diverse. If leaders can be the maximum sensitive to employees' needs, they will be able to make effective decisions in the management.

4.2 Human Nature Hypothesis Theory

Any organized activity is the management of human activities. Since it is the management of human activities, the understanding of humans is necessarily involved. On the issue of how to understand the human nature, the subject of management made a variety of assumptions in the West, and these different hypotheses of human nature then form the cornerstone of Western management psychology.

In 1965, American psychologist Edgar Schein (Liu and Xu 2003) summarized various theories of human nature popular in the West as assumptions of "economic man (Dewey 1930; Lu and Shanjian 2002)", "society man (Schein 1980)", "self-fulfillment man (Daniel 1991)", "complicated man (Guisheng 1998; Mayo 1945; Feng and Li 2005)", which show that the evolution of Western management view of human nature is studying the essence of human nature. One element that can reflects the human nature most is the human need.

Maslow (Frank 1987) proposed the need hierarchy theory in his book "theory of human motivation", who divided human needs into five levels (Maslow 1970): physiological needs, safety needs, social needs, respecting needs and needs of reality. When individuals meet their higher needs, individuals may be close to the fulfillment of self-realization. In general, the physiological and safety needs are lower, material needs; social networking, respect and self-fulfillment are higher, spiritual needs. Maslow believed that human needs would be gradually increased. It was not until the lower needs were met that higher level needs were strengthened or became a major need.

4.3 A General Establishment of Human Needs Evaluation Model

In a civilized society, nature needs of every person cannot be single, even being single, we can conclude that the need of that person on other aspects is 0, so we can group individuals who are in the same type of needs for together for a consolidated analysis.

Different people may differ in range of living environment. Generally speaking, people living in broad vision find it difficult to meet their needs, while people who live in a narrow environment are relatively easy to be satisfied. A person's level of satisfaction is relative compared with other people in his environment. The better one's circumstance is than many others, the higher their level of satisfaction will be, or low.

A person's circumstance is a-dimensional vector, which is consisted of levels of needs being met:

The circumstance = $\{need1, need_2, \ldots, need_n\}$
Malosse's needs hierarchy theory indicates that circumstance is made up of five components:
The circumstance = {physiological needs, safety needs, social needs, respects needs and self-realization needs}
Each component is a vector; it also has its own components. For example:
Physiological needs = {clothing, food,living,shelter and sexual …},
In Marxist theory on human nature, circumstances vector is made up of three types of components:
The circumstance = {Nature needs, social needs, needs of thinking property}
The evaluation of individual circumstances can be thought of the increase of average of levels of satisfaction. That is:
Circumstance assessment = $k_1 \times need_1 + k_2 \times need_2 + \cdots$
$k_n \times need_n$

Among them,

$$k_1, k_2, \ldots, k_n \geq 0,\ k_1 + k_2 + \cdots + k_n = 1$$

The value of personal evaluation of the circumstance do not accurately reflect the degree of personal satisfaction of the circumstance, and further, when individuals are to assess the circumstance, they need to compare with other people's circumstances. Take a simple example: an individual's test score was 80, whether this score is high or low needs to reference others' scores. A man's level of satisfaction with his circumstance is highly correlated with the percentage of the number of other people who live better in their circumstances.

Marking U_i as environmental effects (degree of satisfaction), n_i as the number of people who live better in their circumstances than others, $\delta_i = \frac{n_i}{N_i}$, so

$$U_i = f_i(\delta_i)$$

In which function f_i is an increasing function, that is
$f_i'(\delta_i) > 0$.

Taking the individual differences into account, different people may evaluate differently for the same δ, that is, $U_i = f_i(\delta) \neq U_j = f_j(\delta)\ (i \neq j)$

In fact, person i's N_i can be different from Person j's N_j. There is no universal significance for examining possible situations.

Generally speaking, individuals are small, individuals who live in groups will be assimilated by the group and will accept spirits of groups, not possible of being incompatible with groups. Otherwise he would be left out of this group or that he leaves this group automatically. So what is this group? Standing on the global point of view, a group is a nation, standing on a national perspective, a group can be either a province or an industry or a department, and so on. You can say it's true that a group is a collection of individuals which are classified under a universally-recognized norm which has a comparable quality, in statistics, it is a cluster. In other words, for most people in the group, for almost all the individuals i, evaluation function f_i remain the same, which can be applied to all evaluation function f, so

$$U_i = f(\delta_i)$$

A unique objective criteria for comparing the circumstance of two people does not exist. Circumstance of a person is a multidimensional vector formed by various aspects of the survival needs of people. For a single component of circumstance, there exists a criteria to judge its value, but for multidimensional vector, only comprehensive evaluation is useful, a uniform standard for which is absent. (weights are not the only criteria). For individual i and individual j, individual i may consider his circumstance be inferior to that of individual j, and individual j may also consider he lives in an inferior circumstance to i, that is, when the average is weighted, individual i and individual j may select different weighting coefficients, which leads to the incomparability of two individual circumstances.

As a result, there is a group judgment for circumstances of individual i and individual j, and individual i and j (After some time) would accept the judgment. Therefore we can say that there is a uniform measuring method for value δ.

For a closed group, this analysis is reasonable, because it is impossible to let it not be. There are very few adventurers brave enough to leave his group. Before the reform and opening up, we just lamented the wealth of material life in developed countries, taking no action to pursue, only few people dare to put into action illegally. The stowaway who zooms his survival environment compares his utility U in a larger group; meanwhile, he also increases his weight coefficient of material needs in an integrated evaluation circumstance, which makes their utility value very low in world groups. So that he selects stowing away, in the hope of obtaining his expected utility. Of course, this is just wishful thinking (Shouse 1987).

For an open group, people will unconsciously zoom their survival environment, comparing the current "small environment" with that "large environment" they have seen; in accordance with their value standard, they will compare circumstances they get in "small environment" with that of others in a "large environment" to evaluate its utility, which is then marked as U''; when $U'' - U'$ is attractively big enough, he will appeal to the " large environment". In the early days of reform and opening up, few people turned themselves into businessman. Reasons may be that people considered low circumstance in the "large environment"; people knew and felt a big ratio of material component or money in that environment, other components did not significantly improve, and value judgments, weight of the material is not particularly large, $U'' - U'$ isn't big enough to attract people to leave "small environment" (McGregor 1960). Today, Job-hopping is common among people because the "environment" is more transparent, people can accurately preview their circumstances, and value judgments remains notable changes, as long as U'' is larger than U', it will be attractive enough. However, the vast majority of people still prefer a relatively stable circumstance and they are willing to seek survival and development in the context of the groups.

Theoretically, in a large group, if there is a utility function, there is always a small group whose circumstance is the best. For example, in the broad group of countries, the circumstance some monopoly industries (small groups) is much better than others (Dong 2010). In General, the effectiveness and efficiency of these industries are not the best, they benefited mainly from monopoly. So how do you make those effective individuals in groups work actively, or reduce their evaluation of the circumstance so as to achieve the purpose of reducing their effectiveness? Here, we show a simple and practical way (Argyle 1987).

Forming part of their circumstance of vector components can be divided into two categories:

The circumstance = {material treatment, mental treatment}
Circumstance assessment = k × material treatment + $(1-k)$ × mental treatment $(k \in (0-1))$

The peculiarity of the industry determines their material welfare, in order to effectively reduce their material welfare are both difficult and unreasonable. Consequently, we can consider reducing its mental treatment. We cannot change the evaluation of the industry as a whole by the entire society, but we can create a certain atmosphere of urgency by means of certain management within the industry. For example, to strengthen the management of individuals through public announcements or public supervision; another example, the individual will be expelled from the group if the individual is complained by the public for certain times. In this way, individuals will have a certain sense of urgency in the spirit, whose mental treatment will fall. At the same time, individuals will highly value this, and thus increases their weight coefficient of spirit treatment in the evaluation of the circumstance $(1-k)$. Both will bring down results of the evaluation of circumstances, so as to achieve the purpose of group effectiveness.

4.4 Conclusions and Recommendations

Management master Drucker has addressed the idea of "full employment of people", he thought people can't just "hire one hand", with which the owner is connected. Implementing proper human resources management is the most basic means of managing a company. Successful business managers are also successful on the management of human resources, because they know what their employees really need and in which aspects they hope for their maximum satisfaction. That's why they always have a number of capable and effective, independent and very confident people.

For enterprises' establishing criteria for evaluating the performance of work, that is, in the evaluation of the circumstance, weighting coefficient of material welfare and spiritual treatment k remain unchanged, if the individual evaluation of the circumstance is higher than the industry as a whole, at this time, individual δ is higher and human needs are at a high level. Therefore, on the whole, the enthusiasm of improving performance by their employees does not raise, since higher performance will only bring better material welfare and spiritual treatment, and does not significantly increase their evaluation of the circumstance, so individual needs of human nature is almost unchanged. If you improve work performance standards, analyses above show that there is a decline in both individual circumstance assessments, allowing individual human needs assessment becoming decreased markedly. In order to obtain or maintain existing levels of human needs assessment, individuals will have to work hard to achieve the original circumstance assessment levels to achieve this purpose. So we need to improve employees work performance evaluation standards, lower the evaluation of their circumstance. Only in this way can be more effective in selecting and employing people and creatively exerting their abilities, and only in this way can we see the true integration of employees and enterprises.

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Chapter 5
An Analysis of the Factors Influencing the Enterprise's Cooperation and Innovation Risks in Western Minority Regions of China: Based on a Sample of 100 Enterprises in Minority Autonomous Areas of Gansu Province

Ji-yuan Liu and Ping Zhang

Abstract Based on the 100 samples of enterprises in minority autonomous areas of Gansu Province, this paper analyses the factors that affect technological innovation in western minority areas by adopting the approach of model analysis. Result of the analysis shows that the success or failure of enterprises' technological innovation can be jointly affected by following factors: technical factors represented by the technical capability of the enterprise and the information of its cooperative partners; mechanism factors represented by the treatment of R&D personnel, incentive mechanism, and supportive factors represented by the government support, financing support, and so on.

Keywords Influencing factors · Minority areas · Technological innovation

5.1 Introduction

The scientific and technological innovation force in Western Minority Areas is relatively weak, but these areas do have some basis and conditions, and a great number of scientific and technological innovations have emerged, showing huge benefits, taking on great functions of pushing and driving (Zhou 2002). According

J. Liu (✉)
School of Foreign Languages, Northwest University for Nationalities,
Lanzhou, China
e-mail: ljy2_99@yahoo.com.cn

P. Zhang
Department of Management, Northwest University for Nationalities,
Lanzhou, China

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to the statistics: in 2003, the total number of regional research institutions in the western regions of China is 169; the number of personnel engaged in scientific and technological activities is 737, of which the number of scientists and engineers is 46,150, accounting for 6.3 %. From the status of science and technology and the roles played by the technological innovation in western minority areas, technological innovation and technological progress has been becoming a powerful driving force of economic and social development in these areas. Moreover, the gap between western minority regions and the developed regions of China and those developed countries in terms of science and technology just provides great room for the development of scientific and technological innovation, and it also makes scientific and technological innovation play an even greater role of promoting (Li 2000). As one of the series of studies of the enterprises' technological innovation in western minority areas, this paper focuses on the risk factors of enterprise's cooperative and technological innovation, intending to bring help to the enterprises in technological innovation activities in the western minority areas.

5.2 Methodology

Since 1980, cooperation and innovation presents a momentum of rapid development. Between 1980 and 1994, the growth rate of the number of the alliances between enterprises across the globe is at an average of yearly 10.8 %, far outstripping the growth rate of the development costs in corporate research in the same period (Hagedoorn 2000). Since 1996, R&D budget of the U.S. companies on the external R&D investment has risen from 12 percent to 35 percent, while Japanese companies rose from 40 % to 60 %. Mansfield has pointed out that a considerable proportion of technical success of Japanese companies come from the innovation co-operation, such as alliances and licensing, rather than internal development. Teece has summed up as "to be successful, innovative companies must form a vertical or horizontal external contact with the upstream or downstream enterprises". The empirical analysis also found that cooperation and innovation in technological innovation played a leading role (Cheng 2001). Cooperation and innovation promote the rapid development of technology and productivity, but its high-risk is self-evident. Although there are some common ideas and methods in the theory of risk management, but they cannot be applied simply to the cooperative innovation risk management.

Risk management theory holds that some of the influencing factors are variable, and their changes are objective, randomized, hence the risk variables; some of these factors are relatively stable, and although they do change, they can be controlled (Zhang et al. 2009). These factors can be handled as determining value. But the risk of cooperative innovation itself contains the risk of technological innovation, it also contains the risks brought about by the interactions of the partners. Vyas (1995) and Duysters (1999) held after research that there are seven factors that can cause the failure of the alliance: Failure to understand and adopt the new mode of management requested by the alliance, unable to grasp and understand the cultural differences between the organizations, lack of dedication to the final success, separation of the strategic objectives, lack of confidence, operational or geographic overlap, unrealistic expectations. A survey on 100 British company alliances conducted by Manchester University (UMIST) shows that in technical cooperation the potential risk factors closely related with it are: information leakage, loss of control or ownership, the target dispersion caused by internal disputes. Zhang and Zhang (2003) believe that collaborative innovation is not just a technical process, but also a process of social interaction or mutual game among cooperative parties. Whether the cooperation can be reached and gain an expected benefit depends not only on the technology of all parties, complementarity of all resources and market risks, technology risks and other factors, but also depends on the partners' confidence in each other's level of trust, the relationship between both sides, the effectiveness of communication, and so on. Thus, visible risk factor in the collaborative innovation is a complex concept.

In addition, the common risk assessment methods are: subjective score, Analytic Hierarchy Process (AHP), fuzzy risk evaluation, fault tree analysis (FTA), Extrapolation, Monto Carlo simulation method (Guo 2001; Gao 1997; Gu and Lei 2005; Cheng and Lei 2005). In these evaluation methods, the subjective score can easily be influenced by personal judgment; analytic hierarchy process needs to construct the discriminant matrix; the risk degree of membership of fuzzy comprehensive evaluation is not easy to determine (Harrigan 1988); fault tree analysis focuses on the analysis of the reasons leading to the risk (Littler 1995); extrapolation requires adequate possession of data and need to consider the time factor; Monto Carlo simulation approach is hard to calculate and not proper to be applied to a small amount of raw data (Marxt 1998). Cooperative innovation assessment should not merely be a subjective evaluation and ex-post evaluation, and there is unlikely long reference time and a possession of complete data, so we should not simply adopt the above-mentioned assessment methods.

From the existing research results, we can find that there is no ideal method in terms of cooperative innovation risk assessment, and the main issues focus on two aspects: determination of risk factors and risk assessment. This study attempts to a present a method on these two issues, namely, to solve the identification problem of the risk factors of cooperative innovation by comprehensively utilizing the reliability analysis and factor analysis equations must be included *in-line* with the text. Do not use links to external files.

5.3 Results

5.3.1 Descriptive Statistics of Survey Sample

The survey selected 100 enterprises of Gannan Tibetan Autonomous Prefecture in Gansu Province and Linxia Hui Autonomous Prefecture, distributed 100 copies of questionnaire, of which 60 went to Gannan Tibetan Autonomous Prefecture, 40 to

Linxia Hui Autonomous Prefecture. Ultimately, based on the principle of consistency in answering the questionnaire, the survey selected 75 valid questionnaires for analysis, of which 41 from Gannan Tibetan Autonomous Prefecture, 34 from Linxia Hui Autonomous Prefecture. Valid questionnaires accounted for 75 % of the total proportion of all questionnaires.

In this survey a total of 75 sample enterprises distributing in more than 20 industries are involved, including 6 large enterprises, 69 small and medium-sized enterprises, with state-owned enterprises 6, collective enterprises 8, joint-stock enterprises 20, private enterprises 40. The questionnaire accurately reflects the enterprises' general characteristics of technological innovation, and highlights the characteristics of technological innovation of manufacturing and services enterprises in SMEs. Questionnaire adopts the non-stratified sampling, and of the total sample enterprises, small and medium enterprises, manufacturing and services enterprises occupy a relatively high proportion. This sample can basically reflect the realities of the enterprises' composition and technological innovation in minority areas of Gansu Province.

By taking advantage of the impact factors identified in the research on relative issue of enterprise's technological innovation, this study constructed an impact factor index system of enterprise's technology innovation in Gansu minority areas. This index system consists of a total of 13 factors, and the quantification draw on the assessment method of 1–7 grades marking in existing research. Description of basic statistics is shown as Table 5.1.

In analyzing the impact factors, this paper adopts a combination of methods of α reliability analysis, factor analysis and logistic regression analysis. Firstly, it takes the method of α reliability analysis to examine the reliability of the questionnaire data; second, it uses the method of factor analysis to reduce the dimension of influencing variables, thus arriving at the initial composition of the influencing factors of enterprises' technological innovation in Minority Areas in

Table 5.1 Description of basic statistical variables

Variable name	Average	Standard deviation
Support of senior leadership	5.9571	1.36664
Experience	5.3000	1.18383
Mode selection	4.8714	1.35048
Technological capabilities of the enterprise	5.0429	1.20909
Technical difficulty	4.8429	1.26989
Partner information	4.7429	1.25900
Technology prospects	4.6286	1.50527
Corporate culture	4.1143	1.58382
Management measures	5.3143	1.17391
Treatment of R&D personnel	5.6143	1.24287
Government support	6.3571	1.34095
Financing	6.6286	0.93517
Incentives	5.6286	1.18164

Gansu Province; the final step is to identify the significant linear relationship between success or failure of the enterprises' technological innovation and various factors by taking the method of logistic regression model analysis.

5.3.2 Calculation Results

1. α reliability analysis results. α reliability coefficient score is 0.812 points, meet the reliability requirements of 0.80–0.85's[③] which indicates that 81.2 % of the variation of the survey comes from the proper fraction, only 18.8 % of the variation comes from random errors. All these indicate that the design of the questionnaire is reasonable.
2. Factor analysis results. According to the eigenvalues of the correlation matrix (Table omitted), the explained proportion of the top three factors is more than 15 %, and the cumulative proportion can explain 67.55 % of the data, indicating that it is more reasonable to extract three factors. Table 5.2 shows the factor loadings after orthogonal rotation. This study selects two variables of each factor loading the highest scores as variables of regression analysis. i.e., technological capability of the enterprise and partner information in Factor 1, the treatment of R&D personnel and incentives in Factor 2, government support and capital in Factor 3.
3. Logistic regression analysis results. Construct two logistic regression model by using the above-mentioned six variables impacting the result of technological innovation, and dummy variables are introduced: "success" and "failure", the given encoding is "success" = "1", "failure" = "0". Taking into account the score of "cooperative class variables" in the factor scores were generally

Table 5.2 Factor loadings after orthogonal rotation

Variable name	Factor 1	Factor 2	Factor 3
Support of senior leadership	0.278	−0.548	0.484
Experience	0.760	−0.265	0.265
Mode selection	0.823		0.143
Technological capabilities of the enterprise	0.893		
Technical difficulty	0.711	0.288	
Partner information	0.827		−0.0176
Technology prospects	0.783	0.124	−0.154
Corporate culture	0.500	0.385	0.210
Management measures	0.448	0.688	
Treatment of R&D personnel		0.768	
Government support		0.138	0.891
Financing			0.848
Incentives		0.742	0.424

Table 5.3 Model testing

The final model fit testing		
−2 LL	Cox & Snell R	Nagelkerke R 2
32.125	601	804
Hosmer-Lemshow checklist		
Chi square value	Degrees of freedom	Chi square value
2.030	8	980

higher, dummy variables are introduced: "cooperative" and "no cooperative", the given encoding is "cooperative" = "1", "no cooperative" = "0".

Table 5.3 shows the fit testing of the final model and the Hosmer-Lemshow test, indicating the fitting status of the final model; in the table, the value of 2LL is 32.125, indicating the model reasonably fits the data. The value of Cox & Snell R indicates that 60.1 % of the data are summarized by the model, and the value of Nagelkerke R indicates that 80.4 % of the data summarized by the model, both values are relatively large, and it also shows that the model fits the data well. Statistic of Hosmer–Lemshow Chi square test is 10.614, much larger than 0.05, indicating there is no significant differences in the null hypothesis between the observational data and forecast data, and drawing a conclusion that the model fits the data well.

In the model after the introduction of seven variables, 29 out of 32 are forecast to be "failed" and 3 is forecast to be "successful", the accuracy rate is 90.6 %; 3 out of the actual 38 are forecast to be "failed" while 35 is forecast to be "successful", the accuracy rate is 92.1 % and the overall accuracy rate of prediction is %, indicating that the model can be used to make predictions. Table 5.4 shows the two final logistic regression model data. From the regression results, we can see the variable of "co-operation" is significant at the 0.01 level;" the variable of "incentives" is significant at the 0.05 level;" and the variables of "policy support" and "financing" are significant at the 0.1 level.

Table 5.4 Final model statistics

Variable	Statistics		
	Regression coefficient	Standard error	Wald statistic
Technological capabilities of the enterprise	−0.006	0.578	0.000
Partner information	0.148	0.532	0.077
Treatment of R&D personnel	−0.346	0.462	0.561
Incentive	2.651**	0.897	8.732
Government support	−0.683*	0.499	1.878
Financing	−1.902*	0.847	5.039
Co-operation	7.363***	2.115	12.117
Constant item	4.868	4.868	0.001

Note *, **, *** stand for $P < 10$ %, $P < 5$ %, $P < 1$ % respectively

5.4 Conclusion

From the results of existing research, we can identify as many as 13 factors that exert impact on enterprises' technological innovation, but by adopting the method of factor analysis to reduce the dimensionality, we discover that the major influencing factors are: "technological capability of the enterprise" and "cooperation partner information" of factor 1, the factor 2 "treatment of R&D personnel", "incentives" of factor 2, "Government support" and "financing" of factor 3. According to the characteristics of Variables represented by each factor, this study named three types of factors as follows: technology factor, mechanism factor, and support factors.

1. Technical factor. It includes the influencing factors of enterprise capability, partner information, mode selection, and experience. Such factors account for 35.15 % of the contribution of all influencing factors, indicating that technological innovation in minority areas of Gansu Province is mainly affected by the inherent factors of technological innovation. (a) The loading of the enterprise's technological capability factor scores the highest 0.893 points, that indicates technological capability is the most important to technological innovation of the enterprise, and technological innovation must depend on its own technological capability. Although technological innovation can be carried out through cooperation and other means, as technological innovation has a monopoly in a certain period of time, the stronger the enterprise's technology is, the possibility and lasting time of access to technology monopoly will be bigger and longer. This factor is irreplaceable in technological innovation. The regression analysis shows that the success or failure of technological capability and technological innovation of the enterprise does not have a significant linear relationship, which to some extent reflects that there are many a factors affecting the result of technological innovation, and a strong technological capability of the enterprise does not necessarily bring the success of technological innovation. (b) The loading of the partner information factor scores the second high 0.827 points, numerous studies have demonstrated that technical cooperation is an important way to achieve innovative results. Due to an insufficiency of information of both sides in cooperative innovation, a big information search cost will be caused to the cooperation, and "unethical" or "lazy" behaviors will also arise, thus increasing the monitoring costs. Therefore, a full grasp of the partner information will help to reduce unnecessary costs, increase cooperation trust, thus achieving fruitful cooperation. The regression analysis showed that partner information and the success or failure of technological innovation does not have a significant linear relationship. This result can be interpreted as just an ideal status, and in fact, the partners may by deliberately concealing necessary information, obtain a larger share of innovations.
2. The mechanism factor. It includes management measures, treatment of R&D personnel, and incentives and other factors. Such factors account for 16.717 %

of the contribution of all influencing factors, being the second largest category of factors. (a) The loading of the treatment of R&D personnel scores 0.768 points. Under normal circumstances, the high-tech enterprises tend to stabilize the R&D team by providing them with higher treatment, and encourage R&D staff to achieve innovative results, which is seen as routine management measures to bring the ideal research result. The regression analysis shows that treatment of R&D personnel and the success of or failure of technological innovation does not have a significant linear relationship, which can be interpreted as: first, the uncertainty of technological innovation determines that the high investment in R&D personnel can not necessarily get a good innovation performance; treatment is not necessarily the most important factor in the thinking of high-quality R&D personnel. (b) The loading of incentive factor scores 0.742 points. The importance of incentives to enterprise's technological innovation has been proved by numerous researches. The regression analysis shows that there is a significant positive linear relationship between incentives and the success or failure of technological innovation. Taken into account the analysis result of R&D personnel treatment, we can further discover that for R&D personnel, corporate culture, teamwork, a sense of accomplishment, self-realization are more important than the simple and generous treatment.

3. Support factors. It includes government support, financing and other factors. Such factors account for 15.683 % of the contribution of all influencing factors, ranking the third largest category of factors. (a) The loading of the government support scores 0.891 points. Technological innovation activities of enterprises is actually an important part of the national technology innovation system, therefore, the state should also play an important role in technological innovation activities of enterprises. The regression analysis shows that there is a relatively significant linear relationship between the success and failure of government support and technological innovation, but with a slight negative correlation, indicating that government support may not necessarily be able to bring a good innovation performance. If the government manages and controls too much, a counter-productive result may appear. (b) Financial factors, the loading of the financial factors scores 0.848 points. Adequate financing is a necessary condition of the enterprises' technological innovation, and greater investment enhances the enterprise's ability to resist risks. The regression analysis shows that there is a relatively significant linear relationship between the success or failure of financing and technological innovation, but with a negative correlation, indicating that capital investment is not a sufficient condition of the enterprise's 'technological innovation, and also further proving the complexity of factors affecting the results of enterprises' technological innovation. A strong evidence is: small and medium enterprises often rely on a core technology rather than capital to make progress in their business activities.
4. Technical cooperation.\It is not hard to discover from the early research on the problem of enterprises' technological innovation and technical cooperation that technical cooperation has a significant impact on the success or failure of technological innovation. The regression analysis of the results of this study

shows that technical cooperation has a significant positive influence (r = 7.363) on the success of technological innovation of enterprises of minority areas in Gansu Province. These results suggest that compared with those enterprises in non-minority areas, enterprises in minority areas of Gansu province share some similarities in terms of the impact of technical cooperation on technological innovation. For the enterprises in minority areas of Gansu Province, the impact of technical cooperation on innovation performance is more obvious, and more significant than other factors. This result suggests that the technological innovation capability of enterprises in minority areas of Gansu is not strong, which results in a very low success rate of enterprises completely independent innovation. So, when carrying out technological innovation, it is necessary for an enterprise to select a right cooperation mode and complement the resources strengths. This is particularly suitable for the enterprises in minority areas.

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Chapter 6
An Empirical Analysis on the Influence of Household Consumption on Economic Growth in Hubei Province

Xi-xiang Sun and Ling-li Deng

Abstract Household consumption is closely related to economic growth. Based on a modified Cobb-Douglas production function, adopting the data of household consumption and economic growth in Hubei Province from 1980 to 2010, this paper establishes the evaluation model and takes ADF unit root test approach, Johansen co-integration test approach and Granger causality test approach to make an empirical analysis on the impacts of household consumption on economic growth in Hubei Province. The results show that there is a stable relationship between household consumption and economic growth in the long run. The relationship between them presents positive correlation. Economic growth in Hubei Province is the Granger cause of household consumption. However, the role of household consumption on economic growth is not obvious. Therefore, Hubei government must fully exploit the potential of household consumption in order to promote sound and rapid economic development.

Keywords Cobb-douglas production function · Economic growth · Granger causality analysis · Household consumption · Hubei province

6.1 Introduction

Since the reform and opening up, China has a rapid economic development, the development of consumption has played an important role. Compared to the rest of the world, despite China's consumption has increased at an absolute amount

X. Sun (✉) · L. Deng
School of Management, Wuhan University of Technology, Wuhan, China
e-mail: sunxx_102@163.com

L. Deng
e-mail: dll123789@126.com

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continuously, household consumption related to gross domestic product has been below the proportion of the level of most countries in the world. Affected by European debt crisis in 2011, investment and export as two cart of promoting the economic growth are slightly weakness, China economic growth slows down. Expending consumers' demand to spur our country economy becomes the main trend.

Hubei Province, as the largest province of the central economic, household consumption impact on economic growth is not fully. According to « Hubei Province national economic and social development statistics bulletin in 2010 » , Hubei Province completes the total output value of 1.580609 trillion yuan in 2010, which has a 14.8 % growth than the previous year at the comparable calculation and has kept double-digit growth for seven years (Fig. 6.1). According to the comparable price, the *GDP* of Hubei in 2011 has an increase of 13.8 %, which has an increase of 362.658 billion Yuan than last year. The national ranking rises from by 11 in 2010 to the 10 in 2011. The amount of *GDP* in Hubei Province is more 39.85 billion Yuan than Shanghai. Having 68.047 billion Yuan increased, household consumption of Hubei Province in 2010 reaches 5136.78 billion Yuan. It is to say that household consumption of Hubei Province goes up from 4456.31 billion Yuan in 2009 to 5136.78 billion Yuan. From 1980 to 1990, the household consumption of Hubei Province in *GDP* increased from 47 to 53 %. But from 1990 to 2000, although the *GDP* and the household consumption of Hubei Province have a certain degree of growth, the proportion of household consumption on *GDP* dropped from 53 to 45 %. More strangely, from 2000 to 2010, the rate straightly descends from 45 to 34 % (Fig. 6.2). Hubei Province is to regard household consumption as the key of economic development in the next five years. Thus, probing into relationship of household consumption and economic growth to fuel economic growth is of theoretical and practical significance on the background of domestic and international economic environment.

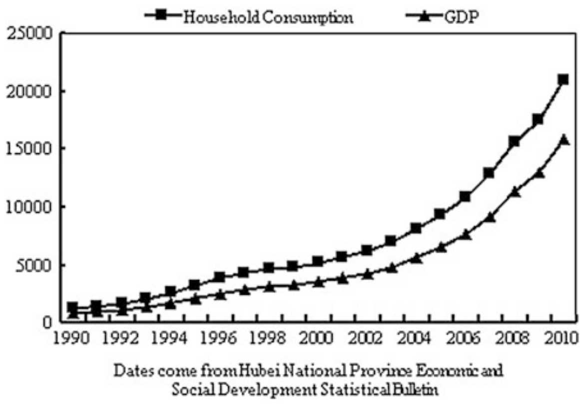

Fig. 6.1 1980–2010 Household consumption and economic growth chart

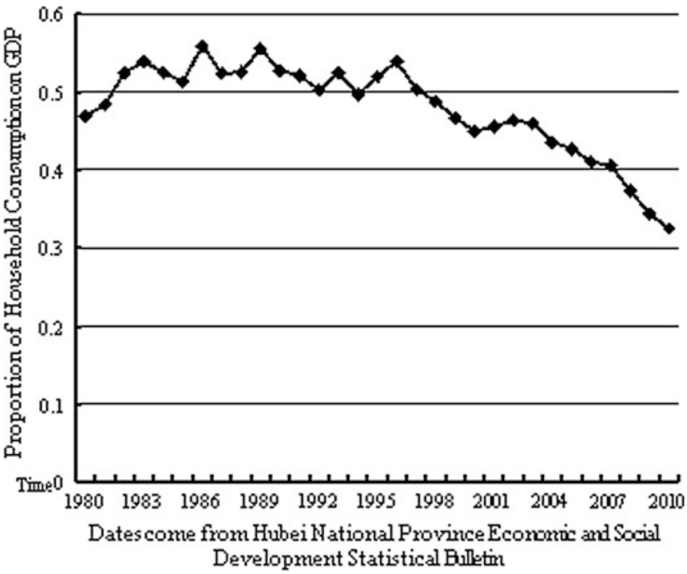

Fig. 6.2 Proportion of household consumption on *GDP*

6.2 The Literature Review

Many studies of scholars research on the economic impact of household consumption. These researches are broadly divided into two categories: macro researches and Meso researches. Macro researches pay attentions to economic growth and household consumption in the angle of country, such as Xiong (2010), Que and Ma (2010), Yang (2010), Ma (2004), Hall and Patteosrn (1156), Deaton and Muelbaue (1980); Meso researches are based on specific Provinces to consider the relationship between household consumption and economic growth, such as: Ma (2007),Wu et al. (2006), Li (2007), Cui (2010) and so on.

Based on their investigation of different emphases and evaluation index, many scholars probed into the theory and practice of household consumption in Hubei Province. Using the dates from 1980–2010 in Hubei Province, Meng (2011) makes a co-integration analysis on the relationship between the consumption level of urban resident in Hubei Province and the disposable income. The results show that there exists long-term equilibrium relationship between income and consumption in 1987–2009 in Hubei Province. (Peng and Huang 2011) applies the linear expenditure system model (ELES) to make a comparative analysis of the differences in the structure between urban and rural consumption in Hubei Province, indicating that the various relatively levels of Hubei consumer expenditure and income are high, except that urban resident household equipment and services, recreation, education and cultural services and rural resident transportation and communication, recreation, education and cultural services and miscellaneous goods and services fit the poor, the fit degree of the rest reached above 0.90, which has a good fit degree. Fang (2009) adopts two indexes-consumption elasticity, consumption pull contribution rate to analysis the promotion role of household consumption on economic growth. Making One-way study the effect of household consumption on economic growth, researches about household consumption mainly force on Urban and rural household consumption on economic growth. The study of economic growth on household consumption is currently blank. In view of this, this paper makes an consider on the relationship between household consumption and economic development since reform and opening up. Through establishing household consumption to economic growth Cobb-Douglas production function and using co-integration theory and error correction model, England causality test to compensate for the deficiencies of the traditional econometric approach in research methods, this paper details the relationship between the household consumption and economic growth and discusses that the impact between household consumption and economic growth is forward, reverse or bi-directional relationship since the reform and opening up for Hubei Province in the 12th Five-Year Plan to expand consumer demand as a long-term mechanism to provide the empirical basis. The innovation points is that based on building Cobb-Douglas production of economic growth and household consumption, this paper on one hand probes into the contribution rate of the household consumption on economic growth, on another hand, searches deeply for the causal relationship between *GDP* and household consumption, thus provide theoretical and practical reference for the economic development of Hubei Province.

6.3 Experimental

6.3.1 The Household Consumption Production Function Model

Cobb-Douglas production function was originally created by the production function U.S. mathematician Cobb (C.W.Cobb) and the economist Paul Douglas (PaulH.Douglas), which discusses the relationship between inputs and outputs. Based on adopting the standard form of the Cobb-Douglas production function, Scholars constantly change and expand the use of the Cobb-Douglas production function to apply it to the fields of economic growth and econometrics. The standard form of Cobb–Douglas production function is below (Schotter 2002):

$$Y = A K^{\alpha} L^{\beta}$$

Among them, the dependent variable Y represents the output, Independent variables K and L respectively are on behalf of capital investment and labor input. α, β, respectively, on behalf of capital, labor productivity elasticity. A is the level of technology parameters.

On the basis of the Cobb-Douglas production function, this study combines with the relationship between household consumption and economic growth, establishes the evaluation model of the Cobb-Douglas production function of household consumption and economic growth.

The household consumption has a direct contribution to *GDP,* however the number of resident affects household consumption, then has a indirect impact on *GDP*. According to the Cobb-Douglas production function, the number of residents and household consumption as the explanatory variables of the two effects of *GDP*, to build the production function of *GDP* on household consumption, the formula is:

$$GDP = k \times CC^a \times N^b$$

Here *CC* presents for household consumption, a for consumer elasticity coefficient, $0 < \alpha < 1$; N is the number of residents, b coefficient of elasticity for the number of residents, $0 < b < 1$; k is the constant coefficients of equations, indicating that other factors have impacts on *GDP*. As the production function formula of the *GDP* on the household consumption is a non-linear model that can't be directly estimated. Use ordinary least squares estimation method, linear the formula by seeking the natural logarithm on both sides of formula:

$$LOGGDP = LOGk + aLOGCC + bLOGN$$

In order to accurately measure household consumption in Hubei impact on economic growth, simplify the equation. It is as follow:

$$LOGGDP = C + LOGCC + U$$

Among the equation, C represents a constant that contains other factors that cannot be explained by *CC. A* indicates elasticity coefficient of *CC* growth on *GDP* growth. *U* means the error term. This function formula is a linear model, *LOGCC* as the independent variable, *LOG GDP* as the dependent variable. This study takes the method-the parameters of the equation ordinary least squares estimation to estimate the elasticity coefficient of the household consumption value with EViews6.0 software (Gao 2009).

6.3.2 Data Processing

The used data of this paper is from 1980–2010 years of annual data, comes from the Hubei statistical yearbook (each related annual). This paper selects the relevant data for analysis, using *GDP* to measure the total economic output, regard household consumption as a measure of *GDP* index. Through the logarithm of *GDP*, *CC*, they will be recorded as *LOGGDP* and *LOGCC* respectively. Because logarithmic transformation of *GDP*, *CC* not only can eliminate the trend of *CC* growth and *GDP* growth, but also can reduce the heteroscedasticity problem of the model fitting residuals. The most important point is that logarithmic transformation manifests the Co-integration relationship of *GDP* and *CC,* So as to better reflect the relationship between elastic values. The corresponding first-order difference sequence is recorded as *DLOGGDP* and *DLOGCC*. In the process of analysis, this paper uses EViews6.0 software to obtain relevant measurement statistics.

6.3.3 Statistical Analysis

Time series analysis is based on the stationary time series after getting time series data. In order to better observe the relationship between *GDP* and *CC*, firstly we carried out the description of statistical analysis of sequence, using Eviews6.0 software to draw the timing diagram (Fig. 6.3), a first sequence diagram (Fig. 6.4). The results show that the first-order difference of *LOGGDP* variables has stability, the first-order difference sequence of *LOGCC* may be a stationary sequence. But unit root test should be done further, so we select ADF unit root test, the level has the time sequence of trend and constant. Therefore, choose a time trend and constant term in the inspection of level sequence, the first difference sequence contains constant. Lag order of the unit root test of the difference sequence is determined by AIC criterion minimum information (Xing and Ma 2011).

6.3.4 Unit Root Test

Using Eviews6.0 software, according to the test results, *LOGGDP* and *LOGCC* ADF statistics test value of the absolute value is more than significant level of 1, 5 and 10 % of the absolute value of the critical value, it shows that *LOGGDP, LOGCC* existing unit root is non-stationary series. However, *LOGCC* after the first order differential-*DLOGCC* is stable at the 5 % of significant level, *DLOGGDP* is

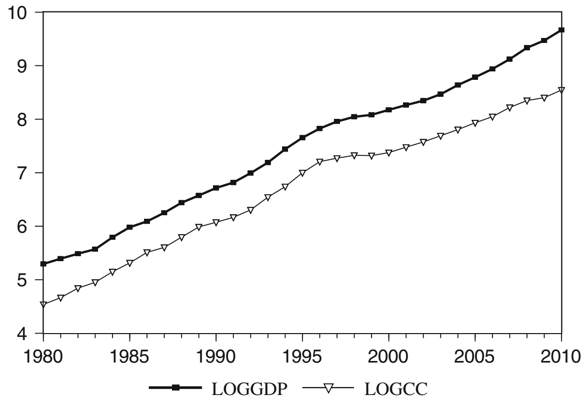

Fig. 6.3 Timing diagram of *LOGGDP* and *LOGCC*

Fig. 6.4 Timing diagram of *DLOGGDP* and *DLOGCC*

on smooth at the 10 % of significant level. Therefore, the level of sequence is non-stationary series, the first-order difference stationary sequence. *LOGGDP* and *LOGCC* is integrated of order one sequence. Based on the above analysis, it can generally be convicted that time series data sheet of the whole order of household consumption in Hubei Province and *GDP* growth are the same. However, to determine whether these two time series are co-integration relationship, it needs to further use EG test or Johansen co-integration test method to test the two time series.

6.3.5 Co-Integration Analysis

The existing precondition of co-integration relationship is that only the two-variable time series are the stable of the same order of a single whole sequence. Therefore, firstly use the ADF unit root test on the smooth and single-order of the two-variable time series .

LOGGDP and *LOGCC* is a one order single whole I sequence, using Johansen co-integration test inspection co-integration relationship between economic growth and resident consumption in Hubei Province. According to the inspection results (Table 6.1), it can be built the following co-integration regression equation (standard deviation in parentheses):

Johansen Co-integration test expression is below:

$LOGGDP = 0.988340 LOGCC$

Co-integration equation of all testing items has passed. It shows that every 1 % increase of household consumption in Hubei Province can pull economic growth around 0.988340 %. It says that household consumption has a significant driving effect on economic growth on long run.

Table 6.1 Johansen co-integration test result

1Co-integrating equation(s):	Log likelihood	106.7017
Organized co-integrating coefficients (standard error in parentheses)		
LOGGDP	LOGCC	
1.000000	−0.988340	
	(0.02510)	
Adjustment coefficients (standard error in parentheses)		
D(LOGGDP)	0.030470	
	(0.14855)	
D(LOGCC)	−0.406242	
	(0.16233)	

6.3.6 Granger Causality Test

The positive correlation of household consumption and economic growth may be out of household consumption helping economic growth or economic growth promoting household consumption. Based on the co-integration relationship between *LOGGDP* and *LOGCC*, the paper establishes the short-term volatility and long-term equilibrium linked vector error correction model, examines on the household consumption and economic growth with the method of Granger causality test, thus further clear the influence of forward and reverse, or two-way between household consumption and economic growth. Vector error correction model can directly describe Short-term volatility and long-term equilibrium of *LOGGDP* and *LOGCC*. The study gets error correction model results with Eviews6.0 software (Table 6.2). It is as follows:

$CointEQ1 = LOGGDP + 0.154984LOGCC - 0.1652$

From statistical significance test results of VAR mode, it can be seen, the change of *GDP* growth in Hubei Province is Granger reason of the change of household consumption growth rate in the short term. Among them the value of P is 0.033316097, obviously, this kind of Granger reason is very prominent. The lag phase of *GDP* growth rate (*LOGGDP*) in Hubei Province can be remarkable to explain and predict the household consumption growth rate (*LOGCC*). However, inspection results show that the alteration of household consumption growth rate is

Table 6.2 1980–2010 Granger causality test of Gdp and Cc

Dependent variable: D(LOGGDP,2)			
Excluded	Chi-sq	df	Prob.
D(LOGCC,2)	4.69828861	5	0.453798989
All	4.69828861	5	0.453798989
Dependent variable: D(LOGCC,2)			
Excluded	Chi-sq	df	Prob.
D(LOGGDP,2)	12.10962919	5	0.033316097
All	12.10962919	5	0.033316097

not Granger reason of economic growth rate. It means that the lag phase of the household consumption growth rate (*LOGCC*) in Hubei Province can't be striving to explain and predict *GDP* growth rate (*LOGGDP*).

6.4 Results

Even though time sequence diagram of two variables- household consumption and *GDP* is not steady, they have become stable after seeking first-order difference. There is a certain stable equilibrium relationship in both of two. Co-integration analysis shows that the household consumption and *GDP* of Hubei Province have a long-term equilibrium co-integration relationship. The household consumption in Hubei Province increases every 1 %, which can draw *GDP* growth of approximate 0.988340 %. It can be obtained from above that the household consumption of Hubei Province has obviously heaving effects on economic growth. Granger causality test shows that household consumption and economic growth have a positive causality. That is to say economic growth is the Granger causes of household consumption. It can promote consumer. However, household consumption is not the Granger reasons of economic growth.

6.5 Conclusion

To sum up, since the reform and opening up, the growth of the economy of Hubei Province has largely promoted the enhancement of household consumption level, but the increasing of household consumption can't directly drive economic growth in short term. In the environmental pollution increasingly serious today, the way of seeking economic growth for our country will transfer from pursuing economic growth rate to economic growth quality. Hubei government will comply with this tend, walk the quality path of economic development. How to realize the nice and fast development of *GDP* and household consumption of Hubei Province under the influence of the economic environment, walk a way of optimizing resident's consumption structure and improving the well-being of people.

First of all, vigorously develop economy of Hubei Province, improve the overall benefits of economic development and enhance the enterprise vitality, increase the government financial resources, strengthen the basis of residents' income growth, trying to keep the basic synchronous of town residents' income growth and per capita *GDP* growth, realizing leapfrog revolution from "low income and high consumption" to "high income and high consumption" in Hubei Province.

second, purify market, make people dare to consumption, rest assured consumption, increase the infrastructure construction, improve consumer environment. The government creates a fair market environment, attracts personalized, vogue, and brand enterprises. The government's quality inspection, prices and industry and commerce departments should strengthen the supervision of material market. On one hand, it stimulates consumption and diversifies the demands of consumers, on the other hand, ensures that people can buy good and cheap products.

Finally, complete social security system of Hubei Province, adjust the industrial structure, and moderately push consumer credit, pull the consumer. Improving the social security system, not only builds consumer confidence, but also promotes the adjustment of industrial structure. Adjust the industrial structure, vigorously develop the tertiary industry to adapt to green economic development, cultivate new hot spots of consumption, attract the consumer. In addition, it is necessary to actively promote consumer credit policy to stimulate consumption, lag consumption of the residents into a credit support ahead of consumption in order to maintain the consumer role in promoting sustained economic development.

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Chapter 7
Analysis of Competency Elements Based on Grey Cluster

Hao-jie Liu, Yan Xu, Jia-hai Yuan and Min-peng Xiong

Abstract A competency model requires lots of competency elements, and competency elements are the most important part of the competency model, so it is necessary to select best data from these elements to make competency model more efficient and satisfactory. This paper describes reviews on competency and introduces the method of grey cluster analysis, and proposes a procedure using grey clustering method to select main competency indexes and evaluates accuracy and performance of the classifying method. Then a case study is presented in the paper to show the viability of the procedure.

Keywords Competency elements · Correlation coefficient · Grey cluster

7.1 Introduction

The theory of competence proposed has made a tremendous impact on the theory research and practical application for human resources management. Therefore, building human resources competency model has greatly important significance. But in the competency modeling process, the competency elements are often complex and with a certain redundancy by behavioral event interview (BEI), brains storm, expert panel discussion, questionnaire survey and other methods. So it is difficult to get a satisfied competency model and bring much inconvenience for a better evaluation, personnel selection and other administrative works based

H. Liu (✉) · Y. Xu · J. Yuan · M. Xiong
School of Economics and Management, North China Electric Power University, Beijing, China
e-mail: xwyfy@sina.com

H. Liu
Qinghai Electric Power Corporation, Xining, Qinghai, China

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on the competency model. To solve these problems, before building the model, it is necessary to select the competency elements. Through the investigation, it has always been principal components analysis, factor analysis and some other statistical analysis methods (Zhang and Shi 2009; Yang 2007; Jin et al. 2012; Zhang et al. 2011; Clelland 1973). In view of previous studies, we propose a selection method of competency elements based on the gray clustering analysis. Making use of the competency elements extracted by the method can make the model more reasonable and practical. Compared with other mathematical methods, the purpose of choosing grey clustering method lies in the following two aspects. Firstly, it could avoid some quantitative methods such as principal component analysis which requires a better distribution of large sample, large computation, the results incompatible with the qualitative analysis and other issues. Secondly, it could overcome the ambiguity and incompleteness of information for the evaluation index, and thus enhance the credibility and scientificity of the competence model.

We begin the rest of the paper by providing more background on the application of the competence, and making a review of grey cluster analysis for the work. Next, we describe how we build the competence model of human resource managers with grey cluster method and evaluate accuracy and performance of the classifying method. Finally, we conclude with an overall discussion.

7.2 Literature Review

This section describes reviews on competency concepts and introduces theory and method of grey cluster analysis.

7.2.1 Competency and Competency Model Overview

In 1973, McClelland (Liu et al. 2012) in American "psychologist" magazine published a paper called "test competence rather than intelligence", which is proposed to replace the traditional intellectual competence measurement, and stress from the first-hand information directly to explore the work of those who can really affect the performance of individual conditions and behavioral characteristics, in order to improve organizational performance and promote the success of personal career and make a substantial contribution, and meanwhile propose six principles of effective competency-based tests. This marks the beginning of the competency movement, but also for competence lays the foundation for the birth of the theory, and then people begin to conduct a study of competence. Competency can be described in iceberg model. Knowledge, skills floating in the water belong to representations of the competency, which are very easy to find. But values, attitudes and self-image, motivation and personality traits hidden under water belong to the competency of potential, which are more difficult to discover more underwater, but those potential features are indeed the key factors to determine the behavior and performance for people.

Competence model is a collection of competence elements required to serve as a particular role for task, including the different performance of motives, personality and quality requirements, self-image and social role characteristics, the level of knowledge and skills. These behaviors and skills must be measurable, observable and guided, meanwhile, which can make a critical impact on the employee's personal performance and business success. Therefore, competence elements are the basis of competence model (Li 2010).

7.2.2 Grey Clustering Method

Grey clustering method (Li 2010; Wei 2001; Zhang and Shi 2008) is a multidimensional grey assessment based on the whitening function of grey number. In the light of a number of grey types, it will summarize albino numbers owned by cluster object for different cluster indicators and thus determine which grey type the cluster object belongs to.

1. The Introduction of Grey Clustering Method

   Set up two sequences:

$$\begin{aligned} X_0 &= \{x_0(1), x_0(2), .., x_0(m)\}. \\ X_1 &= \{x_1(1), x_1(2), .., x_1(m)\}. \end{aligned} \tag{7.1}$$

   Due to X_0, X_1, yield initial point zeroing X_0^0, X_1^0, as follows:

$$\begin{aligned} X_0^0 &= \{x_0^0(1), x_0^0(2), \ldots, x_0^0(m)\}. \\ X_1^0 &= \{x_1^0(1), x_1^0(2), \ldots, x_1^0(m)\}. \end{aligned}$$

   In which, $x_0^0(k) = x_0(k) - x_0(1), x_1^0(k) = x_1(k) - x_1(1), k = 1, 2, \ldots, m$

$$\text{Let } S_0 = \sum_{k=2}^{m-1} x_0^0(k) + \frac{1}{2} x_0^0(m)\,, \quad S_1 = \sum_{k=2}^{m-1} x_1^0(k) + \tfrac{1}{2} x_1^0(m)\,. \tag{7.2}$$

The gray correlation coefficient of X_0 and X_1 is

$$\varepsilon = \frac{1 + |S_0| + |S_1|}{1 + |S_0| + |S_1| + |S_0 - S_1|}. \tag{7.3}$$

Now there are observation m objects, every observation object has n feature data. Obtain the following sequences:

$$\begin{aligned} X_2 &= \{x_2(1), x_2(2), \ldots, x_2(m)\}, \\ X_1 &= \{x_1(1), x_1(2), \ldots, x_1(m)\}, \\ &\cdots \\ X_n &= \{x_n(1), x_n(2), \ldots, x_n(m)\} \end{aligned}$$

Calculate the gray correlation coefficient ε_{ij} of X_i and $X_j - (i \leq j,\ i, j = 1, 2, \ldots, n)$. Clearly have $\varepsilon_{ij} = 1(i = j)$.

The size of the threshold $\tau(0 \leq \tau \leq 1)$ can be determined according to the needs of the practical problems. General requirements are $\tau \geq 0.5$. If τ is closer to 1, the cluster is slender, and the characteristics of each class is less. If τ is smaller, the cluster is wider, and the characteristics of each class is more. When $\varepsilon_{ij} \geq \tau$, suppose X_i and X_j are similar characteristics in τ level. So we have got such a cluster which is got by the characteristics $X_1, X_2, \ldots, X_n$ $\varepsilon_{ij} \geq \tau$ in τ level.

When X_i and X_j are positive correlation, their corresponding numbers S have the same sign (either positive or negative), and $|S_i - S_j|$ are smaller, the correlation coefficient are greater. When X_i and X_j are negative correlation, their corresponding numbers S have the opposite sign, and $|S_i - S_j|$ are greater, the correlation coefficient are smaller. Therefore, when X_i and X_j are similar characteristics in τ level, we consider they are positive correlation.

7.3 Case Study

Through the key behavioral event interview, expert panel discussion method, doing some research on human resources manager and related personnel, and preparation of questionnaires to assess competence, we get human resources manager competence elements with a higher frequency: innovative thinking, communication and expression, results-oriented, team leaders, learning ability, professionalism, subordinate management, conceptual thinking and analysis, honesty and integrity, confidence, organization and coordination, decision making, predictability, execution, achievement motivation and other 15 items. The above factors are defined as to.

Select 50 interviewees and provide number, randomly generate 10 observations from them, and arrange their assessments on the average score of human resource manager competence elements in 15 characteristic sequences. Each series has 10 data. As the elements of this evaluation data are quantitative data, the minimum is zero, the maximum is five and without reverse indicator, so we do not need for data preprocessing and obtain the raw data. The original data table is shown in Table 7.1.

Table 7.1 The original date

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}
T_1	4	4	4	3	4	4	3	4	3	3	3	3	4	4	2
T_2	5	5	5	4	4	5	3	3	5	5	5	5	4	5	4
T_3	2	5	3	4	5	5	5	5	5	5	4	4	5	5	3
T_4	5	4	4	4	4	4	4	4	5	5	5	5	4	4	4
T_5	3	5	2	4	4	4	4	4	4	4	4	5	4	4	4
T_6	4	4	4	3	4	4	3	4	5	5	5	5	4	4	2
T_7	4	4	4	5	5	4	4	4	5	3	3	3	5	5	5
T_8	3	5	3	5	5	5	4	4	4	4	4	4	5	4	4
T_9	5	5	5	4	4	4	3	3	5	5	5	3	4	5	4
T_{10}	5	4	3	5	4	3	3	4	5	5	5	5	4	5	5

According to formula (7.1), obtain initial point zeroing:

$$
\begin{aligned}
X_1^0 &= (0, 1, -2, 1, -1, 0, 0, -1, 1, 1) \\
X_2^0 &= (0, 1, 1, 0, 1, 0, 0, 1, 1, 0) \\
X_3^0 &= (0, 1, -1, 0, -2, 0, 0, -1, 1, -1) \\
&\ldots \\
X_{15}^0 &= (0, 2, 1, 2, 2, 0, 3, 2, 2, 3)
\end{aligned}
$$

According to formula (7.2), obtain $|S|$.

$$
\begin{aligned}
|S_1| &= |1 - 2 + 1 - 1 - 1 + 1 + 0.5 * 1| = 0.5 \\
|S_2| &= |1 + 1 + 1 + 1 + 1 + 1 + 0 * 0.5| = 5 \\
|S_3| &= |1 - 1 - 2 - 1 + 1 - 0.5 * 1| = 2.5 \\
&\ldots \\
|S_{15}| &= |2 + 1 + 2 + 2 + 3 + 2 + 2 + 0.5 * 3| = 15.5
\end{aligned}
$$

According to formula (7.2), obtain correlation coefficient of X_i and X_j.

$$
\varepsilon_{12} = \frac{1 + |S_1| + |S_2|}{1 + |S_1| + |S_2| + |S_2 - S_1|} = \frac{6.5}{11} = 0.59
$$

$$
\varepsilon_{13} = \frac{1 + |S_1| + |S_3|}{1 + |S_1| + |S_3| + |S_3 - S_1|} = \frac{4}{6} = 0.67
$$

Request of any two sequences in this absolute correlation, clearly have $\varepsilon_{11} = \varepsilon_{22} =, \ldots, = \varepsilon_{15,15} = 1$.

We only put grey correlation in Table 7.2, and classify them according to Table 7.2. When definite threshold τ=0.75, Then 15 indicators can be divided into four categories, namely:

Category 1, Specific thinking $\{X_1, X_8\}$:
Innovative thinking, conceptual thinking, analytical skills;
Category 2, Personal qualities $\{X_9, X_{10}, X_{15}\}$:
Honesty and integrity, confidence, achievement motivation;

Table 7.2 The gray correlation coefficient

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	X_{11}	X_{12}	X_{13}	X_{14}	X_{15}
X_1	1.00	0.59	0.67	0.55	0..64	0.67	0.58	0.83	0.53	0.54	0.54	0.54	0.64	0.60	0.52
X_2		1.00	0.77	0.76	0..82	0.77	0.92	0.64	0.67	0.70	0.72	0.74	0.82	0.95	0.67
X_3			1.00	0.64	0..93	1.00	0.71	0.75	0.59	0.61	0.62	0.63	0.93	0.8	0.60
X_4				1.00	0.67	0.64	0.81	0.57	0.82	0.89	0.92	0.96	0.67	0.74	0.83
X_5					1.00	0.93	0.77	0.71	0.61	0.63	0.64	0.65	1.00	0.80	0.89
X_6						1.00	0.73	0.75	0.59	0.61	0.62	0.63	0.93	0.80	0.58
X_7							1.00	0.62	0.70	0.74	0.76	0.78	0.77	0.88	0.70
X_8								1.00	0.54	0.56	0.56	0.57	0.71	0.65	0.55
X_9									1.00	0.91	0.88	0.85	0.61	0.67	0.98
X_{10}										1.00	0.96	0.93	0.63	0.69	0.92
X_{11}											1.00	0.96	0.64	0.70	0.89
X_{12}												1.00	0.65	0.72	0.86
X_{13}													1.00	0.85	0.61
X_{14}														1.00	0.66
X_{15}															1.00

Category 3, the core capability $\{X_2, X_3, X_5, X_6, X_{13}, X_{14}\}$:
Communication and expression, results-oriented, predictable, executive ability, learning ability, professionalism;
Category 4, management $\{X_4, X_7, X_{11}, X_{12}\}$:

Team leader, subordinate management, organization coordination, making decision.

We have classified human resources managers' competence elements by grey clustering method. The classification results can sum all elements required for human resource managers, while combined with the relative importance of work and comprehensive results of the performance, we select X_8, X_9, X_{15}, X_2, X_6, X_{13}, X_4, X_{11}, X_{12} as the competence elements of human resources manager, and meanwhile build human resources manager competence model.

7.4 Conclusion

The paper uses the principle of gray clustering method to extract and streamline the elements of competence, each competence model formed by those entries not only strengthen the integration of competence model and business, but also ensures reliability and validity of the model. So it is clear that competency factors affecting the performance of managers are apparent from the bottom of the iceberg, which helps enterprise to assess managers' situation analysis and prediction of performance improvement. The competence model can be used in multi-dimensional evaluation, selection, targeted training and other human resources development works.

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Chapter 8
Analysis on the Technological Innovation Mechanism of Regional Equipment Manufacturing Industry Cluster

Liang-qun Qi, Cheng-dong Wang and Li–li Lu

Abstract Technological innovation is the source of technological progress and competitive promotion for regional equipment manufacturing industry cluster. By analyzing the technological innovation mechanism with the technological innovation and industrial cluster theories together, this paper mines the key influencing factors of technological innovation of regional equipment manufacturing industry cluster. On this foundation, this paper provides scientific and theoretic basis not only for analyzing the technological innovation modes of regional equipment manufacturing industry cluster, but also for finding the ways to promote the technological innovation level and enhance the competitive advantage.

Keywords Industrial cluster · Influencing factors · Innovation mechanism · Tegional equipment manufacturing industry · Technological innovation

8.1 Introduction

Equipment manufacturing industry is fundamental industry for regional economy, and its developing level reflects the comprehensive economic strength of a region at a certain extent. After a long period development, the equipment manufacturing industry in China has become a wide-range, considerable-scale and high-quality industry system. And it has been the pillar industry of economic development (Gao 2009). In recent years, the equipment manufacturing industry becomes more and more centralized and scale because of the advantages of industry cluster, and the equipment manufacturing industry cluster has become the focus of academic research. However, because the equipment manufacturing industry cluster in

L. Qi · C. Wang (✉) · L. Lu
Department of Management, Harbin University of Science and Technology, Harbin, China
e-mail: chengdong28@163.com

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China is still at primary developing period, the study on industrial cluster is lack of the equipment manufacture industry part. There are many shortages of Chinese equipment manufacture industry in technological innovation area when compare with the international advanced level. These shortages caused that, the Chinese equipment manufacture industry at an inferior status in international competition. As we know, technological innovation has a lot of positive functions for equipment manufacturing industry cluster, such as changing the production technological foundation, reducing production costs, improving product quality and production efficiency. Beside that, technological innovation plays a core role of competitiveness of regional equipment manufacturing industry cluster.

At present, there are a lot of studies on technological innovation of the industrial cluster both domestic and foreign. Gregersen and Johnson (1997) use the 'learning economy' as an analytical framework to discuss how the process of European integration affects national systems of innovation. European integration is described as a process of institutional learning (Gregersen and Johnson 1997). Baptista and Swann (1998) analyzed whether firms located in strong industrial clusters or regions are more likely to innovate than firms outside these regions (Baptista and Swann 1998). Negassi (2004) points out that, R&D cooperation between firms is one of the many strategies by which this knowledge may be transmitted (Negassi 2004). Cheng and Zheng (2009) proposed a reverse double-boom evolutionary model to analyze the co-evolution of technological regimes and industrial clusters of developing counties, in which the first technological and industrial boom is led by market dominance forces and the second boom is led by science and technology dominance forces (Cheng and Zheng 2009). Li and Liu (2011) point out that, the industrial clusters based on cluster technology innovation networks can provide a long-term and stable competition and cooperative mechanism of technological innovation, reduce the cost of technological innovation, incentive to tacit knowledge's learning and communication, and provide an effective channel for the technology diffusion (Li and Liu 2011). Mao and Cui (2010) made an empirical analysis of technological innovation in industrial cluster based on innovative network (Mao and Cui 2010). The achievements of these studies are valuable for analyzing the technology innovation mechanism of industry cluster. And from the studies above, we can see that, the achievements about technology innovation of regional equipment manufacturing industry cluster is still less. So, further study on technological innovation mechanism of regional equipment manufacturing cluster is necessary and feasible (Mansfield 1998).

This paper analyzes the technological innovation motivation of regional equipment manufacturing industry cluster firstly, and makes a systematic analysis on technological innovation process of regional equipment manufacturing industry cluster in the following. On these foundations, this paper builds up a technological innovation system for regional equipment manufacturing industry cluster. Beside that, this paper summarized the influencing factors of technological innovation. This paper provides scientific basis and reference not only for researching technological innovation of regional equipment manufacturing industry cluster, but also for making economic policy by government.

8.2 Technological Innovation Motivations of Regional Equipment Manufacturing Industry Cluster

8.2.1 Profit-Driven of the Core Enterprise

In order to protecting the dominant position in the market competition and pursuit excess profit, the innovation subjects must to do technological innovation activities. This paper argues that the purpose of equipment manufacturing enterprises is seeking for profit, and technological innovation is a very useful way to achieve its purpose. The core enterprises of regional equipment manufacturing industry cluster control most part of product supply in the market, though there is only a small number of the core enterprises. In technological aspect, the core enterprises master leading technology of the industry, and put their resources into technological innovation in order to keep competitive advantage and excess profit. Technological innovation brings huge profits for the core enterprises, and it also brings competitive pressure to other enterprises. Driven by profits, the other enterprises of equipment manufacturing industry cluster begin the imitation innovation, which is benefited by knowledge spillovers and technology diffusion. In this way, the technological innovation becomes more and more critical for equipment manufacturing industry cluster, and the technological level of equipment manufacturing industry cluster is improved.

8.2.2 Demand-Driven of Market

By analyzing the development of both domestic and foreign advanced equipment manufacturing industry, we found the equipment manufacturing industry is driven by domestic demand. Beside that, the domestic demand also supports the technological innovation activities of equipment manufacturing industry cluster. The market demand is more powerful then a "smart" government in promoting technological innovation of regional equipment manufacturing industry cluster (Sun 2010). The market demand is not only the source but also the ultimate goal of technological innovation of equipment manufacturing industry cluster, and it is the main external motivation of technological innovation. Market demands of technological innovation of equipment manufacturing industry cluster include these two aspects: one is the consumer demand of products and service of equipment manufacturing industry; another is demand of equipment manufacturing industry itself.

8.2.3 Promoting Effect of Science and Technology Development

Product of equipment manufacturing industry has a lot of characteristics, such as complex structure, high-level technology and diversification of single parts. These characteristics make the equipment manufacturing industry to be a typical technology-intensive industry. The huge profit caused by scientific progress and application of new technology becomes a powerful impetus of technological innovation of regional equipment manufacturing industry cluster. Recently, information technology has begun to infiltrate every aspect of equipment manufacturing industry, and the usage of high technology in upgrading and reforming the regional equipment manufacturing industry cluster become the trend. Science and technology play a fundamental and critical role in technological innovation of regional equipment manufacturing industry cluster.

8.2.4 Guidance of Government Policy

The policy of government is an important factor for guiding the technological innovation of regional equipment manufacturing industry cluster, and it is also an important impetus of technological innovation. Because most of the equipment manufacturing products related to the national security and national economic lifeline, government enacting a series of technological policies for guiding the technological innovation of regional equipment manufacturing industry cluster in order to set developing aims of technological innovation.

The policy of government has significant influence on input resources and passion of technological innovation of regional equipment manufacturing industry cluster; it is an important external motivation of cluster technological innovation. Beside that, the policy shows the development direction of equipment manufacturing industry, which towards greater profit (Li et al. 2010). In addition, motivation of technological innovation of regional equipment manufacturing industry clusters is depended on several factors: market system, economic environment and legal environment. And all the factors mentioned before are guided by policy of government. So, we can infer from the discuss above that, the regional cluster policy is important driving factor of technological innovation of regional equipment manufacturing industry clusters, especially for the cluster policy which is promulgated for particular region.

8.3 Technological Innovation Process of Regional Equipment Manufacturing Industry Cluster

8.3.1 Decision Process of Technological Innovation

With the development of regional equipment manufacturing industry cluster, its market demand and competition become greater then before for its long industry chain. The core enterprises in industry cluster start to innovate in order to meet the demand of external optimal selection and obtain the expected benefits. Firstly, the core enterprises evaluate the current technology innovation capability of the whole cluster. After that, the core enterprises identify the market demand and innovation resources of cluster. In this way, a preliminary innovation strategy is set up. Because of the characteristic of equipment manufacturing industry, such as high level technological content and technological demand, the core enterprises should establish contact with colleges and scientific research institutions in cluster if it necessary after making the preliminary technology innovation strategy.

8.3.2 Integration Process of Critical Resources

The production of equipment manufacturing just like special equipment and common parts are technology intensive and capital intensive, and the development and production of them requires substantial resources, such as human, capital and innovation organizations both inside and outside of cluster. Effective usage of these resources, especially for knowledge resources has a direct relation with technological innovation of regional equipment manufacturing industry cluster. Knowledge resource in technological innovation of regional equipment manufacturing industry cluster can be divided into two types: explicit knowledge and tacit knowledge. Explicit knowledge facilitates communication and sharing, but tacit knowledge is stable and hard to be imitated or learned.

8.3.3 Process of Technological Development and Commercialization

The specific market structure of regional equipment manufacturing industry cluster provides security of its technological innovation activities. Technological development of the core enterprises in cluster need technological assistant from supporting enterprises and related institutions, because of its long industry chain and industrial correlation. Interaction and cooperation on the value chain of the core enterprise include the following aspect: interaction between enterprises;

cooperation between enterprises and research institutions; cooperation between enterprises and intermediary institutions or financial institutions. The interaction and cooperation happened both inside and outside cluster are made by an integration team which includes experts, researchers and policymakers. Basic research achievements can be got through collaboration of the entire integration team, and they will be applied in products and services. The usage of the new research achievements in equipment manufacturing industry can significantly improve its quality and function, and bring innovation interest to the whole cluster. The consumers' demand for services and products can be conveyed to the innovators, such as production enterprises, R & D organizations, and basic research institutions through the demand effect; and this demand will guide the innovators' basic research. This process has a certain influence on the market structure, and accelerates the change of market demand. Under the stress of imitation and substitution, core enterprises have to keep learning in order to maintain technological superiority and innovation profit. Learning capability determines its competitive advantage for next round of technological innovation.

8.3.4 Diffusion and Upgrade of Innovation

Technology diffusion is a process for disseminating innovative technologies among potential users by certain channels (Zhao and Wu 2010). Technology diffusion is more meaningful than technology innovation in the inside of regional equipment manufacturing industry cluster. Generally speaking, the leading enterprises master the new technologies of the industry cluster. For application the new technologies, the leading enterprises need to cooperate with related enterprises and supporting organizations, this cooperation extends the industrial chain and technological innovation chain. Beside that, application of new technologies promotes the learning and exchange among the innovation subjects in cluster. All these economic activities are bound to make technology diffusion from dominant enterprise to small and medium-sized enterprises. The technology diffusion makes rapid technological improvement of small and medium-sized supporting enterprises in industrial cluster. Corresponding, the technological breakthroughs of small and medium-sized enterprises are important supplement of the leading enterprises' technological shortages. There is technology gap between small and medium enterprises, and this gap can be filled by technology diffusion too. Under the role of the market, technology spread into similar enterprises continuously in industrial cluster, and the potential difference among different enterprises can be compensated, after that, a new round of innovation starts. The finally result of technology diffusion is that, cluster's technological level is strengthened and its technological reserve is increased. Diffusion and upgrade of innovation not only achieve collaborative innovation, but also accelerate the new round innovation and achieve circular upgrading of innovation.

8.4 Influencing Factors of Technological Innovation of Regional Equipment Manufacturing Industry Cluster

The analysis above shows that, the technological innovation process of regional equipment manufacturing industry cluster is dynamic. In this process, many resources need to be integrated, managed and organized. Innovative aim of regional equipment manufacturing industry cluster is carried out though organized flow and interaction of the innovative elements and resources, and it is under the influence of various kinds of factors both inside and outside of innovative system. Some of the factors have directly influence on technological innovation activities, and they will be explained in details in the following parts.

8.4.1 Input Factors of Technological Innovation

Innovative input factors are prerequisite for technological innovation activities of regional equipment manufacturing industry cluster, because the input level of these factors is main symbol of practical creativity and potential output of technological innovation (Liu et al. 2008). Products of equipment manufacturing are technology intensive and capital-intensive products, and they need a lot of talent and capital support. Entrepreneurs play a critical role in technological innovation of regional equipment manufacturing industry cluster, so their qualities not only have a significant impact on technological innovation decision of cluster, but also show the direction and strategy of technological innovation. Innovation talent promotes the generation of innovation concept, ensure the inputs of information and resources of innovation processes, and ensure the liaison and coordination of activities in innovation processes (Yetim and Yetim 2006). The establishment of an effective mechanism of technological innovation, outstanding talent advantage, and increasing innovation fund are important conditions for making correct decision and ensuring smooth realization of the innovation process for regional equipment manufacturing industry cluster. In addition, the shortage of innovative inputs caused the shortage of technological innovation power of Chinese equipment manufacturing industry. So, more R & D talents and funds are needed. In this way, independent intellectual property rights of core technologies and common technologies of equipment manufacturing industry could be developed. And in this way, competitive advantage of Chinese equipment manufacturing industry could be obtained based on cost and resource advantages.

8.4.2 Factors of Technological Innovation Capability

The process of technological innovation of regional equipment manufacturing industry cluster is companied with technological change and technological realization, technological innovation capability is dynamic measure of the overall technological level of the cluster. Innovation capability of the cluster is formed and improved on the present foundation, and it plays a leading role in technological innovation activities. R & D capabilities of the core enterprises and collaboration supporting capacity of the supporting enterprises are most important parts of innovation capability. Better capability of technological innovation is helpful for obtaining techniques and integrating knowledge. In this way, the regional equipment manufacturing industry cluster could format the independent intellectual property right, build the core competence, and occupy the high-level segment in international division. Excellent manufacturing equipment industry can absorb and transform technology into innovation achievement effectively with low cost, and the flexible sales system and services system in cluster can quickly realize sales income, and capture the market (Xiang 2010). In the continuous technological innovation activities, constant improved technology and innovation capability affect the innovation as important input variables of cluster innovation system of regional equipment manufacturing industry.

8.4.3 Factors of Technology Diffusion Channel

Technology diffusion channel of regional equipment manufacturing industry cluster is a critical influence factor of its technology diffusion, and it is happened between technology suppliers and demanders actively. The technology diffusion channel provides a channel for diffusing technology form core enterprises to small and medium-sized enterprises. Technology diffusion channel plays a bridge role on the cluster overall innovation. Effective diffusion channels not only means fluent technological information exchange and excellent information dissemination, but also means rapid occurrence of technology spillover or indirect technology transfer. In this way, technology diffusion of regional equipment manufacturing industry cluster become more and more quickly. The effect of technology diffusion also accelerates the process of next round innovation. There are many channels for diffusing technology of regional equipment manufacturing industry cluster, such as import and export, international technology trade, domestic and foreign technology alliance and so on. In recent years, FDI becomes one of the most important channels of international technology diffusion. FDI achieves indirect transfer of technology and knowledge through economic activities about materialized advanced technology, and it is beneficial for the cluster to undertake foreign advanced technology. Therefore, regional equipment manufacturing industry cluster should attract foreign investment actively, and establish foreign investment mechanism in order to obtain technology.

8.4.4 Organizational Factors of Technological Innovation

Technological innovation process of regional equipment manufacturing industry is a coordinated and cooperated process between not only internal organizations but also internal and external organizations. Successful technology innovation of the cluster is a realization process of technology innovation of both the individual enterprise and the cluster. Therefore, to establish a reasonable and efficient technological innovation cooperation organization, strengthen the contact of enterprises, universities and research institutions within the cluster, promote the knowledge integration are important activities to achieve technological innovation aim. Common innovative organization models of cluster are learning organization, networked and virtual organization, but with the growing competition of international market, condition of market becomes unstable. So a new organizational form for technological innovation, which named technological innovation dynamic alliance become a better choice for regional equipment manufacturing industry cluster.

8.4.5 Factors of Government Policy

Government policy is primary factor of technological innovation of regional equipment manufacturing industry cluster (Fu and Li 2009). The development process of equipment manufacturing industry in developed countries shows that, development of equipment manufacturing industry is inseparable from the government's policy. The main developed countries, such as United States, Germany and Japan, developed their equipment manufacturing industry later than Britain, but they transcend Britain ultimately, one of the most important reasons is the government attaches great importance to the equipment manufacturing industry. Government policy includes two aspects: policy support and policy regulation.

8.5 Conclusions

This paper put focus on the technological innovation motivations and process of regional equipment manufacturing industry cluster, and build the innovation system. On this foundation, this paper summarized the key factors affecting the technological innovation of regional equipment manufacturing industry cluster. The conclusions of this paper as following:

1. Technological innovation of regional equipment manufacturing industry cluster is a dynamic circulative accumulation process, and it is driven by regional market competition and market demand, technical progress, guidance of regional policy, pursuit of max benefits of the core enterprises. The circulated process of technological innovation of regional equipment manufacturing industry cluster is: innovation decision-integration of resources-technology development and commercialization-technology diffusion and upgrade-innovation decision.
2. Technological innovation of regional equipment manufacturing industry cluster is composed of a series of activities, and these activities formed technological innovation system of regional equipment manufacturing industry cluster. This technological innovation system is a complex system, which related to a lot of interactions between different innovation subjects.
3. Realization of technological innovation of regional equipment manufacturing industry cluster is influenced by technological innovation input, technological innovation capability, technology diffusion channel, innovative organizations, and government policy. These factors influence the technological innovation not only in different way, but also at different degree. The most important and critical factor is technological innovation capability.

By analyzing the technological innovation mechanism, this paper mines the key influencing factors of technological innovation of regional equipment manufacturing industry cluster. Also, this paper provides scientific and theoretic basis not only for analyzing the technological innovation modes of regional equipment manufacturing industry cluster, but also for finding the ways to promote the technological innovation level and enhance the competitive advantage.

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Chapter 9
Analyzing International Scientific Collaboration in Materials Science Through Co-authorship

Dan Xiang

Abstract International scientific collaboration has growing rapidly for all countries. This paper looks into the international scientific collaboration for USA, China, Germany, England and Japan from co-authorship by using data from ESI hot papers in materials science. Association analysis has been introduced to examine in pairs the cooperative relation between the countries. We find that USA takes the dominant position in the internationally co-authored papers in materials science, and China ranks the second. USA and China are closely connected in co-authored papers, and China relies more on the cooperation with USA than USA on China. England and Germany cooperate more than any other pairs. USA, China, Germany, and England collaborate less with Japan respectively.

Keywords Association rules · Co-authorship · ESI · Hot paper · International scientific collaboration (ISC) · Materials science

9.1 Introduction

International scientific collaboration has been growing rapidly for all counties. It is because ISC provides with researchers a wider range of facilities and resources, and enables them to work with leading people in their fields on the cutting-edge and innovative activities (Schott 1998). Analyzing ISC needs statistical indicators which are sensitive enough to reveal collaborative relations and bibliometric

D. Xiang
School of Mechanical Engineering, Northwestern Polytechnical University,
Xi'an, 710072 Shanxi, China

D. Xiang (✉)
Office of International Cooperation, Northwestern Polytechnical University,
Xi'an, 710072 Shanxi, China
e-mail: xiangd@nwpu.edu.cn

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analysis of co-authored scientific papers turn out to be a promising approach (Wagner et al. 2001). Although there are collaborations that do not lead to co-authored papers, co-authorship is still one of the most tangible and well-documented indicator of scientific collaboration, especially for the intensifying collaboration (Adams et al. 2007). In addition, many aspects of scientific collaboration can be reliably tracked by analyzing co-authorship networks by bibliometric methods (Adams et al. 2007).

Many studies have demonstrated ISC by using co-authorships. W. Glänzel and A. Schubert analyzed scientific collaboration through co-authorship both on individual and national level, with special focus on multinational collaborations (Glanzel and Schubert 2005). Jonathan Adams, Karen Gurney and Stuart Marshall also studied the international collaboration for the UK based on its internationally co-authored papers, and provided reference and suggestion for the UK's international engagement in scientific research and development (Adams et al. 2007). Guo (2010) conducted research on the ISC patterns of China and India based on SCIE through international co-authored papers.

Although many studies have been conducted to analyze ISC by using co-authorship, most are at the general level. This paper looks into the ESI hot papers in material science, which can demonstrate the quality of the collaboration. Association Rules is introduced in this paper to explore the ISC for the USA, China, Germany, England, and Japan.

The paper is organized as follows. Section 9.2 provides the definition of association rules. Section 9.3 gives the dataset retrieved from ESI hot papers in materials science. Section 9.4 presents the results of the analysis. Conclusions are draws in Sect. 9.5.

9.2 Methodology

Association analysis is a methodology for discovering relations hidden in databases. An association rule is defined as: let $I = \{i_1, i_2,\ldots, i_n\}$ be a set of all items in a market basket and $T = \{t_1, t_2,\ldots,t_k\}$ be a set of transactions. Each transaction in T contains a subset of items chosen from I. A collection of zero or more items is defined as an item set, and support count (sc) refers to the number of transactions that contain a particular item set (Tan et al. 2005).

An association rule is an implication of the form X → Y, where X and Y are disjoint items, i.e., $X, Y \subseteq I$ and $X \cap Y = \Phi$ (Agrawal et al. 1993). The strength of an association rule can be measured by support and confidence. Support is often used to eliminate useless rules, and to describe property for the efficiency discovery of association rules (Tan et al. 2005). Confidence measures the reliability of the inference made by a rule, and provides an estimate of the conditional probability of Y given X (Tan et al. 2005).

The support s (X) of an item set X is defined as the proportion of transactions in the dataset which contain the item set:

$$\text{Support } (X \cup Y) = \text{P } (X \cup Y) = \text{sc}\,(X \cup Y)/\text{T}$$

The confidence of a rule is obtained by dividing the support count for $\{X, Y\}$ by the support count for$\{X\}$:

$$\text{Confidence } (X \cup Y) = \text{P } (\text{Y}|\text{X}) = \text{sc}\,(X \cup Y)/\text{sc}(X)$$

In this paper, $i_m, m = 1, 2, \ldots, n$represent the mth country, while $t_l, l = 1, 2, \ldots, k$ represent the lth paper. Therefore, $I = \{i_1, i_2, \ldots, i_n\}$ is the set of courtiers, while $T = \{t_1, t_2, \ldots, t_k\}$ is the set of internationally co-authored papers. A higher result in the support and confidence means a higher frequency of collaboration involved between the countries.

9.3 ESI Hot Papers in Materials Science

9.3.1 Original Data

Essential Science Indicators (ESI) is an ideal resource for complex analyses of scientific literature, and can be used to examine research performance of nations, institutions, authors, journals, to identify significant research trends, and to evaluate potential collaborators, reviewers and peers (http://ip-science.thomsonreuters.com/m/pdfs/mgr/esi-0805-q.pdf). Generally, papers reach their citation peak in two or three years after publication, but hot papers defined by ESI are a small group of papers, which are recognized very soon after publication, reflected by rapid and significant numbers of citations. Therefore, hot papers are the top 0.1 % fraction of papers published in the past two years that receive more citations relative to other papers of the same field and publication date. The data is updated bimonthly (six times a year) (http://esi.webofknowledge.com/help/h_dathot.htm).

The original data for this paper was retrieved from ESI hot papers in materials science for the time period of March and April, 2012. There were 115 hot papers in material science published upon the retrieval time, of which 57 were published in 2010 and 58 in 2011. Among these hot papers, there are 39 internationally co-authored papers and 76 papers published by a single nation, which is called domestic papers in this article.

The information for each paper provided by ESI is citation, title, authors, source, authors' addresses, and field. Since this paper mainly explores ISC in material science, we have to rely on the address information, which makes it possible to study ISC by using countries as the unit of investigation. Therefore, the data analyzed in this paper are records of title, and author's location country, as shown in Table 9.1.

Table 9.1 Top three hot papers in material science

No.	Title	Country
1	For the bright future-bulk heterojunction polymer solar cells with power conversion efficiency of 7.4 %	USA
2	Plasmonics for improved photovoltaic devices	Netherlands, England, USA, Germany, Canada
3	Roll-to-roll production of 30-inch grapheme films for transparent electrodes	Singapore, England, USA, Germany

9.3.2 *Distribution of Countries*

The 115 hot papers in material science are distributed in 24 countries. As for the total number of papers, the top seven countries are USA (55), China (28), Germany (13), Japan (12), England (10), South Korea (8), and Singapore (8), as shown in Table 9.2. The internationally co-authored papers are mainly distributed in USA (22), China (14), Germany (10), England (9), and Japan (7).

Table 9.2 Number of papers published by the 24 countries (Ranked by the number of internationally co-authored papers)

No	Country	Internationally co-authored papers	Domestic papers	Total
1	USA	22	33	55
2	Peoples Republic of China	14	14	28
3	Germany	10	3	13
4	England	10	1	11
5	Japan	7	5	12
6	South Korea	5	3	8
7	Singapore	4	4	8
8	France	4	2	6
9	The Netherlands	4	1	5
10	Australia	3	2	5
11	Canada	3	2	5
12	Russia	3	0	3
13	Switzerland	2	1	3
14	Italy	2	0	2
15	Spain	2	0	2
16	Denmark	1	1	2
17	India	1	1	2
18	Poland	1	1	2
19	Moldova	1	0	1
20	Austria	1	0	1
21	Saudi Arabia	1	0	1
22	Serbia	1	0	1
23	Ireland	0	1	1
24	Turkey	0	1	1

USA takes the dominant position in materials science, and the number of its domestic papers is 33, taking 43.42 % out of the total number of domestic papers. China has 14 domestic papers, taking 18.72 %, and ranks the second. The internationally co-authored papers of USA are the top among the 24 countries and China also the second. Germany, England and Japan perform better in internationally co-authored papers than its domestic papers.

9.4 Analyzing International Scientific Collaboration by Using Association Rules

Among the 115 papers, the number of internationally co-authored papers is 39. We can see from Table 9.2 that apart from Ireland and Turkey, the other 22 countries have cooperated with each other in internationally co-authored papers. The top five countries which have a relatively large number of internationally co-authored papers as listed in Table 9.2 are selected to be analyzed in this part by using association rules.

In Table 9.3, $t_1,\ldots, t_{39}$ represent the 39 internationally co-authored papers, and $i_1,\ldots, i_5$ represent USA (US), China (CH), Germany (GE), England (EN), and Japan (JA) respectively. Support count (sc) for each country is also included. 1 in Table 9.3 means that the country has contributed to the writing of this paper and appears in the address column, while 0 means that the country is not involved in composing this paper.

9.4.1 International Scientific Collaboration for USA

In this section, the ISC between USA and its partner countries are examined. The pairs are {USA → China}, {USA → Germany}, {USA → England}, and {USA → Japan}, and r_1, r_2, r_3, r_4 are defined as the rules for these four pairs.

Examine r_1 (USA → China). Since the support count for {USA, China} is 9 and the total internationally co-authored papers are 39, the support for r_1 is:

$$\text{Support }(r_1) = \mathrm{P}\ (\text{USA} \cup \text{China}) = \\ \text{sc}\,(\text{USA} \cup \text{China})/\mathrm{T} = 9/39 = 0.23$$

Since USA has 22 internationally co-authored papers, the confidence for r_1 is:

$$\text{Confidence }(r_1) = \mathrm{P}\ (\text{China}|\text{USA}) = \\ \text{sc}\,(\text{USA} \cup \text{China})/\text{sc}\,(\text{USA}) = 9/22 = 0.41$$

By applying the same methodology, the support and confidence for r_2, r_3, and r_4 can also be calculated.

Table 9.3 A binary 0/1 representation of internationally co-authored papers

	i_1 = *US*	i_2 = *CH*	i_3 = *GE*	i_4 = *EN*	i_5 = *JA*
t_1	1	0	0	0	0
t_2	0	0	0	0	1
t_3	1	0	1	1	0
t_4	0	0	0	0	0
t_5	0	0	0	0	0
t_6	1	0	1	1	0
t_7	1	0	0	0	1
t_8	1	0	1	1	0
t_9	0	1	0	0	0
t_{10}	1	0	0	0	0
t_{11}	1	1	0	0	0
t_{12}	0	0	1	0	0
t_{13}	1	1	0	0	0
t_{14}	1	1	0	1	0
t_{15}	0	1	0	1	0
t_{16}	0	0	0	0	0
t_{17}	1	1	0	0	0
t_{18}	0	1	0	0	1
t_{19}	1	1	0	0	0
t_{20}	1	1	0	0	0
t_{21}	0	1	0	0	1
t_{22}	1	0	0	0	1
t_{23}	0	0	1	1	0
t_{24}	1	1	0	0	0
t_{25}	1	0	1	0	0
t_{26}	0	0	0	0	1
t_{27}	0	0	1	0	0
t_{28}	1	1	0	0	0
t_{29}	0	1	0	0	0
t_{30}	1	0	0	0	0
t_{31}	1	0	0	0	0
t_{32}	1	0	0	0	0
t_{33}	0	0	1	1	0
t_{34}	1	0	0	0	0
t_{35}	1	1	0	0	0
t_{36}	0	0	1	1	0
t_{37}	0	0	0	1	0
t_{38}	0	0	1	1	1
t_{39}	1	0	0	0	0
sc	22	14	10	10	7

$$\begin{gathered}\text{Support } (r_2) = \text{P } (\text{USA} \cup \text{Germany}) = \\ \text{sc } (\text{USA} \cup \text{Germany})/\text{T} = 4/39 = 0.10 \\ \text{Confidence } (r_2) = \text{P } (\text{Germany}|\text{USA}) = \\ \text{sc } (\text{USA} \cup \text{Germany})/\text{sc } (\text{USA}) = 4/22 = 0.18\end{gathered}$$

$$\begin{gathered}\text{Support } (r_3) = \text{P } (\text{USA} \cup \text{England}) = \\ \text{sc } (\text{USA} \cup \text{England})/\text{T} = 4/39 = 0.10 \\ \text{Confidence } (r_3) = \text{P } (\text{England}|\text{USA}) = \\ \text{sc } (\text{USA} \cup \text{England})/\text{sc } (\text{USA}) = 4/22 = 0.18\end{gathered}$$

$$\begin{gathered}\text{Support } (r_4) = \text{P } (\text{USA} \cup \text{Japan}) = \\ \text{sc } (\text{USA} \cup \text{Japan})/\text{T} = 2/39 = 0.05 \\ \text{Confidence } (r_4) = \text{P } (\text{Japan}|\text{USA}) = \\ \text{sc } (\text{USA} \cup \text{Japan})/\text{sc } (\text{USA}) = 2/22 = 0.09\end{gathered}$$

The higher the support and confidence, more collaboration is involved. We can see from the results that USA plays the dominant role in materials science, and is a strongly dominant partner for China based on their collaborative outputs. USA cooperates less with Germany and England, and the least with Japan.

9.4.2 International Scientific Collaboration for China

This section looks into the ISC for China and four pairs are explored: {China → USA}, {China → Germany}, {China → England}, and {China → Japan}. The rules for these pairs in this section are defined as r_5, r_6, r_7, r_8. Since the sc for China is 14, by using association analysis the support and confidence for the four rules are as follows:

$$\begin{gathered}\text{Support } (r_5) = \text{P } (\text{China} \cup \text{USA}) = \\ \text{sc } (\text{China} \cup \text{USA})/\text{T} = 9/39 = 0.23 \\ \text{Confidence } (r_5) = \text{P } (\text{USA}|\text{China}) = \\ \text{sc } (\text{China} \cup \text{USA})/\text{sc } (\text{China}) = 9/14 = 0.64\end{gathered}$$

$$\begin{gathered}\text{Support } (r_6) = \text{P } (\text{China} \cup \text{Germany}) = \\ \text{sc } (\text{China} \cup \text{Germany})/\text{T} = 0/39 = 0 \\ \text{Confidence } (r_6) = \text{P } (\text{Germany}|\text{China}) = \\ \text{sc } (\text{China} \cup \text{Germany})/\text{sc } (\text{China}) = 0/14 = 0\end{gathered}$$

$$\begin{gathered}\text{Support } (r_7) = \text{P } (\text{China} \cup \text{England}) = \\ \text{sc } (\text{China} \cup \text{England})/\text{T} = 2/39 = 0.05 \\ \text{Confidence } (r_7) = \text{P } (\text{England}|\text{China}) = \\ \text{sc } (\text{China} \cup \text{England})/\text{sc } (\text{China}) = 2/14 = 0.14\end{gathered}$$

$$\begin{gathered}\text{Support } (r_8) = \text{P (China} \cup \text{Japan)} = \\ \text{sc (China} \cup \text{Japan)/T} = 2/39 = 0.05 \\ \text{Confidence } (r_8) = \text{P (Japan|China)} = \\ \text{sc (China} \cup \text{Japan)/sc (China)} = 2/14 = 0.14\end{gathered}$$

Based on the analysis, the USA takes the dominant position in China's ISC. However, the confidence r_5 for {China → USA} is 0.64, higher than confidence r_1 (0.41) for {USA → China}, which means that China relies more on USA than USA on China. China's ISC with England and Japan is also much less than with the USA, and there is no collaboration between China and Germany.

9.4.3 International Scientific Collaboration for Germany

This section analyzes the three pairs of {Germany → USA}, {Germany → England}, and {Germany → Japan}. Since there is no co-authored paper between China and Germany, {Germany → China} is not included in this section. The rules for the three pairs are defined as r_9, r_{10}, r_{11}. The sc for Germany is 10, and following are the support and confidence for these three pairs:

$$\begin{gathered}\text{Support } (r_9) = \text{P (Germany} \cup \text{USA)} = \\ \text{sc (Germany} \cup \text{USA)/T} = 4/39 = 0.10 \\ \text{Confidence } (r_9) = \text{P (USA|Germany)} = \\ \text{sc (Germany} \cup \text{USA)/sc (Germany)} = 4/10 = 0.40\end{gathered}$$

$$\begin{gathered}\text{Support } (r_{10}) = \text{P (Germany} \cup \text{England)} = \\ \text{Sc (Germany} \cup \text{England)/T} = 7/39 = 0.18 \\ \text{Confidence } (r_{10}) = \text{P (England|Germany)} = \\ \text{sc (Germany} \cup \text{England)/sc (Germany)} = 7/10 = 0.70\end{gathered}$$

$$\begin{gathered}\text{Support } (r_{11}) = \text{P (Germany} \cup \text{Japan)} = \\ \text{sc (Germany} \cup \text{Japan)/T} = 1/39 = 0.03 \\ \text{Confidence } (r_{11}) = \text{P (Japan|Germany)} = \\ \text{sc (Germany} \cup \text{Japan)/sc (Germany)} = 1/10 = 0.10\end{gathered}$$

The confidence (r_{10}) is higher than confidence (r_9), and confidence (r_{11}), which demonstrates a closer relationship between Germany and England.

9.4.4 International Scientific Collaboration for England

This section analyzes four pairs of {England → USA}, {England → China}, {England → Germany}, and {England → Japan}. The rules for the four pairs are defined as r_{12}, r_{13}, r_{14}, r_{15}. The sc for England is 10, and the support and confidence for these four pairs are as follows:

$$\text{Support } (r_{12}) = \text{P (England} \cup \text{USA)} = \\ \text{sc (England} \cup \text{USA)/T} = 4/39 = 0.10 \\ \text{Confidence } (r_{12}) = \text{P (USA|England)} = \\ \text{sc (England} \cup \text{USA)/sc (England)} = 4/10 = 0.40$$

$$\text{Support } (r_{13}) = \text{P (England} \cup \text{China)} = \\ \text{sc (England} \cup \text{China)/T} = 2/39 = 0.05 \\ \text{Confidence } (r_{13}) = \text{P (China|England)} = \\ \text{sc (England} \cup \text{China)/sc (England)} = 2/10 = 0.20$$

$$\text{Support } (r_{14}) = \text{P (England} \cup \text{Germany)} = \\ \text{sc (England} \cup \text{Germany)/T} = 7/39 = 0.18 \\ \text{Confidence } (r_{14}) = \text{P (Germany|England)} = \\ \text{sc (England} \cup \text{Germany)/sc (England)} = 7/10 = 0.70$$

$$\text{Support } (r_{15}) = \text{P (England} \cup \text{Japan)} = \\ \text{sc (England} \cup \text{Japan)/T} = 1/39 = 0.03 \\ \text{Confidence } (r_{15}) = \text{P (Japan|England)} = \\ \text{sc (England} \cup \text{Japan)/sc (England)} = 1/10 = 0.10$$

The confidence (r_{14}) for {England → Germany} is 0.70, the highest among all the four defined rules in this section. The confidence (r_{14}) for {England → Germany} is the same with the confidence (r_{10}) for {Germany → England}, which means that Germany and England play an equally important role in each others ISC in materials science.

9.4.5 International Scientific Collaboration for Japan

Section E analyzes the ISC for Japan by the four pairs of {Japan → USA}, {Japan → China}, {Japan → Germany}, {Japan → England}. The rules for the four pairs are defined as r_{16}, r_{17}, r_{18}, r_{19}. The sc for Japan is 7, and the support and confidence for these four pairs are as follows:

$$\text{Support } (r_{16}) = \text{P (Japan} \cup \text{USA)} = \\ \text{sc (Japan} \cup \text{USA)/T} = 2/39 = 0.05 \\ \text{Confidence } (r_{16}) = \text{P (Japan|USA)} = \\ \text{sc (England} \cup \text{USA)/sc (Japan)} = 2/7 = 0.29$$

$$\text{Support } (r_{17}) = \text{P (Japan} \cup \text{China)} = \\ \text{sc (Japan} \cup \text{China)/T} = 2/39 = 0.05 \\ \text{Confidence } (r_{17}) = \text{P (Japan|China)} = \\ \text{sc (Japan} \cup \text{China)/sc (Japan)} = 2/7 = 0.29$$

$$\text{Support }(r_{18}) = \text{P }(\text{Japan} \cup \text{Germany}) = \\ \text{sc }(\text{Japan} \cup \text{Germany})/\text{T} = 1/39 = 0.03 \\ \text{Confidence }(r_{18}) = \text{P }(\text{Japan}|\text{Germany}) = \\ \text{sc }(\text{Japan} \cup \text{Germany})/\text{sc }(\text{Japan}) = 1/7 = 0.14$$

$$\text{Support }(r_{19}) = \text{P }(\text{Japan} \cup \text{England}) = \\ \text{sc }(\text{Japan} \cup \text{England})/\text{T} = 1/39 = 0.03 \\ \text{Confidence }(r_{19}) = \text{P }(\text{England}|\text{Japan}) = \\ \text{sc }(\text{Japan} \cup \text{England})/\text{sc }(\text{Japan}) = 1/7 = 0.14$$

The analysis shows that Japan is loosely connected with the other four countries in the ISC on materials science.

9.5 Conclusion

This paper has analyzed the ISC for USA, China, Germany, England, and Japan based on the dataset gathered from ESI hot papers in materials science by using association analysis. Outcomes of the analysis tell us that USA plays the dominant role in materials science, and is a strongly dominant partner for China based on their collaborative outputs. China is productive in the hot papers in materials science right after USA, and also takes the key position as the partner of USA. Germany and England are also closely related, and confidence (r_{10}) for {Germany → England} and the confidence (r_{14}) for {England → Germany} are the highest among all the 19 defined rules. USA, China, Germany, and England are less productive with Japan.

For further research, we plan to analyze the collaboration among three countries rather than in pairs, and citation will be included to explore the quality of the co-authored papers in addition to the frequency of collaboration.

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Chapter 10
Assessment Study of Power Enterprise Soft Power Based on Fuzzy-ANP

Dong-xiao Niu, Lin Zhu and Dai Mu

Abstract With requirements of lean, meticulous management, power enterprise soft power has become more and more urgent. In this paper, I analyze the operating environment and internal development that are needed in power enterprise, and the principles established indicators and combined with relevant literature and expert opinion. On the basis of soft power in the power enterprise and the basic content elements, I build a power supply enterprise soft power evaluation index system. Soft power research is cutting-edge research-based emotional issues. There are a lot of qualitative indicators, so the paper designs evaluation index value questionnaire. On the index value of the evaluation, I use AHP to calculate the index weight and build soft power evaluation model.

Keywords AHP · Evaluation model · Power supply enterprise · Soft power

10.1 Introduction

Today in the background of economic globalization, to carry out enterprise management activities needs pay attention to the world, learn the international modern enterprise management mode and management concept. The reason why global international enterprises can take up each industry leadership is not only its capital, scale and "hard power", but also is closely linked with its "soft power", such as powerful technology, brand, the prestige and so on.

In order to realize the construction goal of "one strong three excellent" modern international company of state grid, we need to start from two aspects—"hard

D. Niu · L. Zhu (✉)
School of Economics and Management, NCEPU, Beijing, China
e-mail: zhiningzhu@qq.com

D. Mu
School of Energy, Power and Mechanical Engineering, NCEPU, Beijing, China

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power" and "soft power". Between them, the hard power is the material base of the development of power supply enterprises, and the soft strength is the guarantee of continuously improving the hard power in the correct direction and plays a role in a comprehensive efficient way. Since the state grid company was founded, China power grid has made great progresses in "hard power", such as substation capacity, equipment technical level, power supply capacity. In order to make it function in smooth and efficient way, the power supply enterprise need to have more efficient management ability. At present, there is an urgent need for power supply enterprise to evaluate soft power, analyze the important factors of influencing the soft power, and work out the promotion measures.

10.2 Analysis of Soft Power

Soft power is first proposed in 1990 by an American scholar, Joseph nanotubes, since then the "soft power" research and application became the trend. Soft power was gradually recognized by the people as a theory. In many our country development fields, such as foreign and national competition strategy, the soft strength theory used more widely. In recent years, the soft strength theory and connotation further enrich. Its application scope is from the macro field extends to the micro field, and gradually becomes a theory generally accepted in the concept.

For the power supply enterprise, the soft power is the embodiment of the comprehensive ability. Our country is still in a power supply enterprise of rapid development. This period has main features: the technology changing quickly, the scale development strong needs, the investment difficult decision, weak link numerous, service-oriented enterprises heavy construction task, etc. At the same time, the current power supply enterprise at all levels faces urgent task, such as how to support ultra-high voltage grid, how to harness smart grid, how to realize "one strong three excellent".

These traits and task require the power supply enterprise must have the correct understanding and execution ability, which also is good soft strength. Based on the latest soft power theory and the characteristics of the power supply enterprise, we definite the soft power of the power supply enterprise composition. Soft power includes 8 strengths: the strength of learning, thinking, innovation, planning, implementation, control, affinity and appeal.

10.3 Fuzzy-ANP Methodology

10.3.1 Introduction of ANP Method

Professor T.L. Satty, university of Pittsburgh, put forward the independent pass class time structure in the basis of the development of analytical hierarchy process (ANP) in 1996, which is complex system of decision model that can solve existing dependence and internal feedback effect. As the network analytic hierarchy process considering of the mutual influence and disposal between the elements, it can describe the relationship of the real world between the objective things more accurately, so it becomes a more effective decision-making method.

ANP system elements are divided into two parts. The first is the control of factors, including problems target and decision-making rule. The second part is the network layer, which is composed by all the elements in the control group; the interior is network structure influencing each other (Lianfen and Shubai 1990; Shubhai 1988).

We use Delphi method to judge the relative importance of each index in the ANP system. Judging standard generally, we use, is the 1–9 scale method.

The control layer elements of ANP are B_1, B_2,…, B_m.

The network layer element set are C_1, C_2,…, C_N. e_{jk} ($k = 1, 2,\ldots, n_j$) is one of the elements in C_j. By comparing the elements' influence, in C_j, on the e_{jk} ($k = 1, 2,\ldots, n_j$), we can structure judgment matrix, based on the control rule. Then the characteristic root method get sort vector, $\left[w_{i1}^{(jk)}, w_{i2}^{(jk)}, \ldots, w_{in_i}^{(jk)}\right]^T$. If the above characteristic vector through the consistency check, will the written form matrix, and it can get the weight of local vector matrix: Similarly, in turn, will other elements of the relationship between elements set inside and outside is, by the network layer of various elements of the mutual influence ranking vector form shall not be entitled to heavy super matrix W_s.

Each element of the matrix is a matrix, column and for 1; But W is not the normalized matrix. In order to calculate the convenient, it needs to be a super matrix column.

Namely, the elements of the matrix W_s should be weighted. Then we get weighted super matrix.

In the control layer rule, through the comparison of the group elements' influence, in the network layer, on C_j ($j = 1,\ldots, N$), we can get a normalized sort vector:

$H_j = \left[h_{1j}, \ldots, h_{Nj}\right]^T$, then can get weighted matrix H.

Multiplying the matrix H and W, we can get weighted super matrix W.

Stable processing is the limit of the super matrix calculated each relative ranking vector:

$$W^{\infty} = \lim_{k\to\infty} (1/N) \sum_{k=1}^{N} \overline{W}^k \tag{10.1}$$

The original matrix corresponding line of each index of the value of a stable weight premise condition is the limit convergence and only. Through calculating the type, we get value of the weight of each index. ANP calculation process is complicated, so this paper using Super Decisions software example calculation, get the weight of the index (Sun and Tian 2001; Liu et al. 2003).

10.3.2 The Fuzzy Comprehensive Evaluation Method

The fuzzy comprehensive evaluation method is a comprehensive evaluation method that based on fuzzy mathematics. The method changes qualitative evaluation into quantitative evaluation based on fuzzy mathematics theory of membership, which uses fuzzy mathematics to make an overall evaluation for things or object restricted by various factors. It has clear results and strong systemic characteristics. It can well solve problems that are vague and hard to measure. It is suitable to solute all kinds of uncertain problems.

The fuzzy evaluation method gives comprehensive evaluation conclusion, based on the establishment of mathematical model at all levels and fuzzy matrix multiplication the firm's law making, according to "the maximum membership degree".

In the fuzzy comprehensive judgment, the major needed data is the weight of each index factor and the level of evaluation index.

The evaluation object sets, factor sets, comments set. We set up these sets in turn: object sets $O = \{o_1, o_2, \ldots, o_l\}$, factor sets $U = \{u_1, u_2, \ldots, u_m\}$ Comments sets $\mathrm{V} = \left\{v_1, v_2, \ldots, v_j, \ldots, v_n\right\}$, and $\overset{\mathrm{m}}{\underset{i=1}{\cup}} u_i = U$, $u_i \cap u_j = \varphi$, $i \neq j$.

We establish m weight distribution of evaluation factors vector W. Set the weight vectors factor set U for W. This paper all factors set weight vectors are used ANP calculated and determined, then we get $\mathrm{W} = [\mathrm{w}_1, \mathrm{w}_2, \ldots, \mathrm{w}_\mathrm{m}]$, among them, $0 \leq \mathrm{w}_i \leq 1$, $\sum_{i=1}^{\mathrm{m}} w_i = 1$.

By the single factor for fuzzy evaluation fuzzy comprehensive evaluation matrix R: Separate from factors of the evaluation to determine the object to the evaluation for the membership degree to choose element set, become the single factor evaluation. Fuzzy evaluation matrix R is for single factor evaluation matrix. In R, the I element is the evaluated object's membership for the all levels in the evaluation sets. The column j reflects is evaluated object's factors were taken on a level of evaluation in the j degree. I get the last comprehensive evaluation result (Lianfen 2001; Gao 2006; Liu and Junrong 2006).

10.4 Results

According to the index system this paper set up, I evaluate electric power company using questionnaire, and choose relevant experts using 1–9 scoring method to score index and weight of index. Using super decisions software, I calculate the weight of each index that the 10 experts give, and take the average weight of 10 experts as the final index weight (Table 10.1).

Calculation results of soft power components (eight forces) score: the highest scoring 3.922174 is appeal force, and the lowest score 3.688217 is planning force.

Table 10.1 Weights of soft power evaluation of the power supply enterprise

Level 1 index	Level 2 index
Learning ability 0.081506	Learning motivation 0.287422
	Learning perseverance 0.14488
	Learning ability 0.143505
	Learning efficiency 0.17385
	Transforming force0.250345
Thinking ability 0.042816	Thinking basis0.109175
	Thinking speed 0.135796
	Thinking breadth 0.110824
	Thinking highth 0.143472
	Thinking depth 0.201739
	Thinking flexibility 0.298996
Innovation ability 0.049403	Technology innovation 0.13575
	Management innovation 0.187585
	Knowledge innovation 0.258755
	Marketing innovation 0.4147911
Scheming ability 0.080661	Anticipation 0.222043
	Persistent 0.228388
	Integrity 0.244724
	Flexibility 0.304847
Executive ability 0.126318	Executive function 0.194964
	Implementation effect 0.476486
	Efficiency 0.328545
Controlling ability 0.153818	Standard system 0.149928
	Organization system 0.14215
	Information free 0.415556
	Feedback mechanism 0.292367
Appetency 0.225747	Family love service 0.207636
	Harmonious service 0.261886
	Satisfied service 0.267045
	Stars service 0.263433
Influence 0.239732	Social responsibility appeal 0.141849
	The brand image influence 0.207674
	Team morale cohesion 0.405755
	Enterprise culture attraction 0.244722

In general, the force are closed at good level, and it shows that the power supply enterprises' work in soft power is still need further intensify efforts to ascend.

The calculation result of power supply company soft power fuzzy comprehensive evaluation is 66.289 % (38.4909 + 27.7981 %) experts giving more than 4 points. That is to say, 66.289 % of staffs think that this company soft power is in a high level. The power supply enterprise soft power comprehensive evaluation result is 3.848744, which is closed to the good level (4 score) (Table 10.2).

Table 10.2 Weights of eight abilities

	Learning ability	Thinking ability	Innovation ability	Scheming ability
Weight	0.081506	0.042816	0.049403	0.080661
	Executive ability	Controlling ability	Appetency	Influence
Weight	0.126318	0.153818	0.225747	0.239732

10.5 Conclusion

From the table, we can see the weight of the appeal and affinity power is larger in soft power. This is the power supply enterprise to the orientation of serving industry practice.

The power supply enterprise is faced with the customer directly, so affinity and appeal power are the main factors of influences to own the customers and promote enterprise business ability. Therefore, when the power supply enterprises take measures to improve the soft power, these two aspects of content should be given proper attention.

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Chapter 11
Competency Evaluation Engineering of R&D Personnel based on Rough Set

Xiao-feng Liu, Yan Xu, Jia-hai Yuan and Chang-hong Zhao

Abstract Competency model as the emerging matter in the field of human resource management has been greatly concerned. As companies realize the high performance that is produced by talent-post matching, enterprise managers think that competency model is an urgent need to implement competitive advantage. This paper studies the characteristics of R&D personnel, and uses interviews, questionnaires, and behavioral event interviews and other methods to build competency model, then determines the R&D personnel's competency appraisal index, combines with expert evaluation and rough set theory to determine the weight factor of the evaluation, so weight distribution is more scientific and rational to improve the reliability and accuracy of the evaluation.

Keywords Competency · R&D personnel · Rough set

11.1 Introduction

In the era of globalization and knowledge-based economy, the speed of the industrial environment changes gradually accelerated. In order to survive in the globalization system, the enterprises mainly depend on the continuous innovation, and the development of new products relies on the personnel's unique knowledge, skills and professional attitude. Domestic enterprises face the competitive environment of liberalization, and the basic wage continues to rise, and the requirements of transition, continuous innovation for enterprises grow surge. Therefore,

X. Liu (✉)
School of Management, Hefei University of Technology, Hefei, China
e-mail: xwwyfy@sina.com

Y. Xu · J. Yuan · C. Zhao
School of Economics and Management, North China Electric Power University, Beijing, China

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how to obtain and retain excellent human resources for enterprises have become the most important issue, and R&D personnel even are the key for enterprises to own competitive advantage.

For R&D personnel, traditional human resource management based on job analysis has become increasingly inadequate. In the recruitment process, we always consider how to select personnel who truly has the research and development ability, especially in the same extrinsic factors like qualifications, experience. In the performance management process, in order to promote personnel's research and development capabilities, we often consider how to reasonably evaluate the R&D personnel (Kang and Niu 2008). Professor McClelland of Harvard University had made a series of studies for this phenomenon and found there had some crucial factors behind a superior performance, such as attitude, personal qualities, knowledge, and these factors are called "competence" (Mengna 2006). This management model which think the competence as a starting point is different from traditional job analysis methods, which more fit the personnel's work and environment, further convergence with the company's strategy to assist enterprises effectively manage the staff from human resource management and various aspects, improve core competitiveness.

Since McClelland proposed the concept of competence, domestic and foreign scholars had been mainly studied the competency model of corporate middle-and top-level managers or other related personnel. In recent years, the theoretical system of competency continually improves, and the application object and scope constantly expand. The recruitment, talent planning, training and development, career design, performance evaluation and compensation management based on competency also show great effects (Hu 2011). But so far the competency model about R&D personnel is little studied.

This paper hopes to use competency model to explore the construction and evaluation of R&D personnel competency, and use rough set to determine the weight of appraisal factors, and expect to provide a reference for future research and practices.

11.2 The Characteristics of R&D Personnel

Competency model is a high-end human resource management mode in corporation. Its core purpose is to achieve the best match between post and personnel. As competency needs to be reflected in our daily behavior, in order to bring value, the enterprises should define each competency and summarize key behavior which can act as a reference to judge the proficiency of competency model. The competency model of iceberg model is shown in Fig. 11.1. In this model, the underwater part of iceberg is the "potential" that we usually refer, the depth from top to bottom are different, then the difficulty levels of excavated and perception are also different. Relative to the knowledge and skills, the potential part of the competency elements are more difficult to evaluate and train (Peng and Pao 2003).

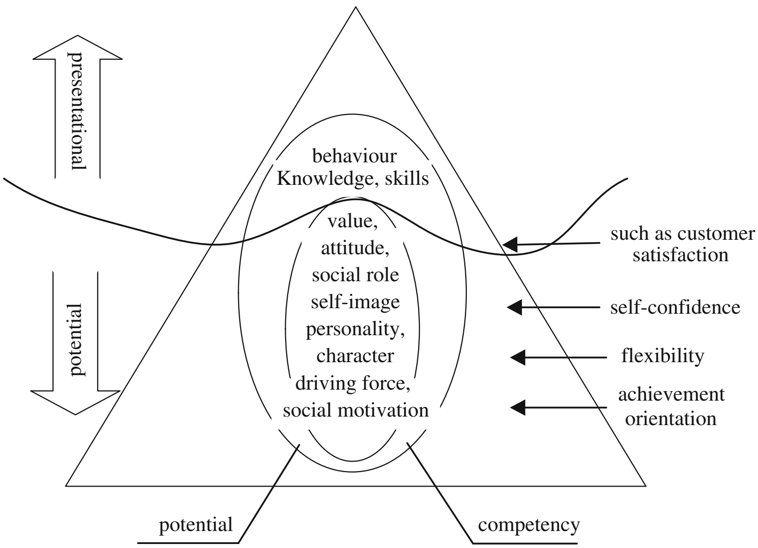

Fig. 11.1 Iceberg model

Compared with the ordinary employees, the work R&D personnel's is the most creative. They primarily explore new areas and create new products in the independent and autonomous environment, and their work is mental work-based, no specific job description, nor a fixed workflow. At the same time, the knowledge and skills which required for research and development work are also professional. With strong specialization, R&D personnel need to keep learning, training and continuing education to maintain their human capital value (Shahhosseini and Sebt 2011).

In addition, the labor achievements of R&D personnel are often new technology, new products and new services, and they are switched into economy profits but are subject to other internal and external resources. Therefore, performance appraisal cycle of R&D personnel will be longer. Also, research and development activities are often used by team work, and the innovation achievements are the fruit of team members' wisdom, so sometimes it is difficult to monitor R&D personnel's work, and accurately measure the level of effort or members' contribution. Therefore, it often results in greater difficulty for performance evaluation of R&D personnel.

11.3 The Construction of R&D Personnel's Competency Model

According to the needs of enterprises' actual situation and business management, and refer to the competency model in similar industry, we can divide the structure of competency into explicit and implicit ability. Among them, the elements of explicit ability include: professional qualifications, expertise, work history and title and so on. Knowledge elements include: expertise, management expertise, production knowledge and company knowledge. The elements of implicit ability include management skills and basic quality. Professional skills and basic quality can form the initial competency project, and define the common quality of R&D personnel based on the organizational culture and values.

The components, design sources, methods and processes of competency model are show in Table 11.1.

The construction of competency model for R&D personnel mainly combines four methods of the interview, questionnaire, behavioral event interview and expert panel discussion.

In the process of structuring R&D personnel's competency model, first of all, we should define the performance standards. For the evaluation object, clear and definite standards can be used to determine and measure which kind of performance is good, which kind of performance is poor. Because of the specificity of R&D personnel's work, the performance standards of this group are mainly based on job analysis. We can refine and decompose the excellent performance standards into some specific tasks, identify and summarize the characteristic of behavior which may promote R&D personnel high performance.

Second, it can use the interviews to understand the comments and suggestions about the construction of R&D personnel's competency model from senior leadership. Before the interview, we should write the interview outline, arrange and analyze the interview content to obtain the major elements constituted competency, namely explicit ability and implicit ability.

Furthermore, on this basis, using a structured questionnaire to conduct behavioral event interview from merit and general incumbent, and through the methods like job analysis, interviews with experts or an expert database to compare and analyze the

Table 11.1 Structure of competency model

Ability category	Definition	Design source	Design methods and processes
Management skills	Engage in management or the work with nature of management should have the common ability	Theory with actual	Design questionnaire by post sequence, count and analyze combined with Interview of benchmarking characters
Common quality	Require common moral character and attitudes of employees	Organizational culture values	Research cultural systems, understand the leadership's management intent
Professional quality	Position require the employee's personality, moral character and attitude	Departmental responsibilities Job responsibilities	Design questionnaire by post sequence, count and analyze combined with Interview of benchmarking characters

key behavioral characteristics of performance differences between two groups, thereby obtaining the competency characteristics which R&D personnel must be had, and combining the collected and classified information to standardization define and classify each competency, and making a behavioral description for different competency levels. Then it will structure the R&D personnel's competency model initially. After, the enterprises should form a group constituted by some experts, discuss the competency elements which belong to R&D personnel's competency model library, and make the appropriate adjustments.

To ensure the rationality of competency model, it is necessary to establish the model testing, and count the frequency that competency project has appeared, then do significant difference test to compare the frequency of elements indicators and related degree statistical indicators between merit and general group, finally identify the similarities and differences characteristics between two groups. Through the construction and validation of R&D personnel's competency model, we determine seven R&D personnel's competency indicators: security awareness, creative awareness, and teamwork, problem-solving skills, communication skills, learning ability, succeed desire. Enterprises can combine questionnaires and expert scoring views to set weights for R&D personnel's competency indicators.

Rough set is a new mathematical tool to deal with fuzzy and uncertain knowledge (Zhu 2007). The essence of multi-index evaluation method based on rough set is trans-forming the problem of weights determining into the evaluation of properties importance of rough set. In the context of data-driven, through the analysis of objects support and importance, we can determine the weights value with comprehensive evaluation model, and the weights are entirely decided by the law of data itself. It uses the evaluation indicators as the condition property, and sets the set of condition property, and the set of decision property. There are 16 experts involved in the evaluation scoring table, and the objects for evaluation are, so the two-dimensional information table formed by is the relational data model on the evaluation objects. The results of pretreatment and discrete data are shown in Tables 11.2 and 11.3.

Table 11.2 Results of pretreatment data

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	D
E_1	0.80	0.67	0.64	0.56	0.80	1.00	0.70	0.83
E_2	0.56	0.33	0.52	0.45	0.60	0.67	0.76	0.68
E_3	0.67	0.47	0.57	0.42	0.69	0.79	0.83	0.76
E_4	0.76	0.69	0.63	0.33	0.78	0.83	0.89	0.72
E_5	0.83	0.67	0.59	0.67	0.88	0.86	0.83	0.75
E_6	0.78	0.84	0.74	0.59	0.78	0.78	0.81	0.86
E_7	0.58	1.00	1.00	0.89	1.00	0.94	0.94	0.77
E_8	0.66	0.37	0.67	0.39	0.64	0.83	0.73	0.78
E_9	0.61	0.47	0.30	0.36	0.67	0.73	0.74	0.77
E_{10}	0.59	0.38	0.59	0.45	0.71	0.86	0.76	0.73
E_{11}	0.68	0.89	0.42	0.33	0.68	0.68	0.76	0.68
E_{12}	0.82	0.64	0.89	0.56	0.86	0.85	0.86	0.83
E_{13}	0.59	0.43	0.39	0.41	0.96	0.69	0.73	0.67
E_{14}	1.00	0.88	0.79	0.85	0.89	0.99	1.00	0.84
E_{15}	0.58	0.47	0.46	1.00	0.62	0.69	0.78	0.72
E_{16}	0.74	0.65	0.72	0.36	0.81	0.89	0.90	0.85

Table 11.3 Results of discrete data

	C_1	C_2	C_3	C_4	C_5	C_6	C_7	D
E_1	2	2	2	2	2	3	1	3
E_2	1	1	1	1	1	1	1	1
E_3	1	1	2	1	1	2	2	2
E_4	2	2	2	1	2	2	2	2
E_5	2	2	2	2	2	2	2	2
E_6	2	3	2	2	2	2	2	3
E_7	1	3	3	3	3	3	3	2
E_8	1	1	2	1	1	2	1	2
E_9	1	1	1	1	1	1	1	2
E_{10}	1	1	2	1	1	2	1	2
E_{11}	1	3	1	1	1	1	1	1
E_{12}	2	2	3	2	2	2	2	3
E_{13}	1	1	1	1	3	1	1	1
E_{14}	3	3	3	3	3	3	3	3
E_{15}	1	1	1	3	1	1	1	1
E_{16}	2	2	2	1	2	3	2	3

Calling MATLAB solver to calculate the set of equivalence classes:

$$
\begin{aligned}
U/ind(D) &= \{E_1, E_6, E_{12}, E_{14}, E_{16}), (E_2, E_{10}, E_{11}, E_{13}, E_{15}), \\
&\quad (E_3, E_4, E_5, E_7, E_8, E_9)\} \\
U/ind(C) &= \{E_1, (E_2, E_9), E_3, E_4, E_5, E_6, E_7, (E_8, E_{10}), \\
&\quad E_{11}, E_{12}, E_{13}, E_{14}, E_{15}, E_{16}\} \\
U/ind(c_2, c_3, c_4, c_5, c_6, c_7) &= \{E_1, (E_2, E_9), E_3, E_4, E_5, E_6, (E_7, E_{14}), (E_8, E_{10}), \\
&\quad E_{11}, E_{12}, E_{13}, E_{14}, E_{15}, E_{16}\} \\
U/ind(c_1, c_3, c_4, c_5, c_6, c_7) &= \{E_1, (E_2, E_9, E_{11}), E_3, E_4, (E_5, E_6), E_7, (E_8, E_{10}), \\
&\quad E_{12}, E_{13}, E_{14}, E_{15}, E_{16}\} \\
U/ind(c_1, c_2, c_4, c_5, c_6, c_7) &= \{E_1, (E_2, E_9), E_3, E_4, (E_5, E_{12}), E_6, E_7, (E_8, E_{10}), \\
&\quad E_{11}, E_{13}, E_{14}, E_{15}, E_{16})\} \\
U/ind(c_1, c_2, c_3, c_5, c_6, c_7) &= \{(E_1, E_{16}), (E_2, E_9, E_{15}), E_3, (E_4, E_5), E_6, \\
&\quad E_7, (E_8, E_{10}), E_{11}, E_{12}, E_{13}, E_{14}\} \\
U/ind(c_1, c_2, c_3, c_4, c_6, c_7) &= \{E_1, (E_2, E_9, E_{13}), E_3, E_4, E_5, E_6, E_7, \\
&\quad (E_8, E_{10}), E_{11}, E_{12}, E_{14}, E_{15}, E_{16}\} \\
U/ind(c_1, c_2, c_3, c_4, c_5, c_7) &= \{(E_1, E_5), (E_2, E_9), (E_3), (E_4, E_{16}), E_6, E_7, \\
&\quad (E_8, E_{10}), E_{11}, E_{12}, E_{13}, E_{14}, E_{15}\} \\
U/ind(c_1, c_2, c_3, c_4, c_5, c_6) &= \{E_1, (E_2, E_9), (E_3, E_8, E_{10}), E_4, E_5, E_6, E_7, \\
&\quad E_{11}, E_{12}, E_{13}, E_{14}, E_{15}, E_{16}\}
\end{aligned}
$$

Exporting the positive field of the set of condition property as follows:

$$
\begin{aligned}
&pos_c(D) = \{E_1, E_3, E_4, E_5, E_6, E_7, E_{11}, E_{12}, E_{13}, E_{14}, E_{15}, E_{16}\} = 12 \\
&pos_{c-|c_1|}(D) = \{E_1, E_3, E_4, E_5, E_6, E_{11}, E_{12}, E_{13}, E_{15}, E_{16}\} = 10 \\
&pos_{c-|c_2|}(D) = \{E_1, E_3, E_4, E_7, E_{12}, E_{13}, E_{14}, E_{15}, E_{16}\} = 9 \\
&pos_{c-|c_3|}(D) = \{E_1, E_3, E_4, E_6, E_7, E_{11}, E_{13}, E_{14}, E_{15}, E_{16}\} = 10 \\
&pos_{c-|c_4|}(D) = \{E_1, E_3, E_4, E_5, E_6, E_7, E_{11}, E_{12}, E_{13}, E_{14}, E_{16}\} = 11 \\
&pos_{c-|c_5|}(D) = \{E_1, E_3, E_4, E_5, E_6, E_7, E_{11}, E_{12}, E_{14}, E_{15}, E_{16}\} = 11 \\
&pos_{c-|c_6|}(D) = \{E_1, E_3, E_5, E_6, E_7, E_{11}, E_{12}, E_{13}, E_{14}, E_{15}\} = 10 \\
&pos_{c-|c_7|}(D) = \{E_1, E_4, E_5, E_6, E_7, E_{11}, E_{12}, E_{13}, E_{14}, E_{15}, E_{16}\} = 11
\end{aligned}
$$

Calculating the dependence that decision property towards the set of evaluation indicators, using the formula:

$$r_{c-|c_i|}(D) = \frac{card(pos_{c-|c_i|}(D))}{card(U)} \tag{11.1}$$

The results are as follows:

$$
\begin{aligned}
&r_c(D) = 12/16 = 0.7500; r_{c-|c_1|}(D) = 10/16 = 0.6250; \\
&r_{c-|c_2|}(D) = 9/16 = 0.5625; r_{c-|c_3|}(D) = 10/16 = 0.6250; \\
&r_{c-|c_4|}(D) = 11/16 = 0.6875; r_{c-|c_5|}(D) = 11/16 = 0.6875 \\
&r_{c-|c_6|}(D) = 8/16 = 0.6250; r_{c-|c_7|}(D) = 11/16 = 0.6875
\end{aligned}
$$

Further, calculating the importance of the condition property towards the decision property, using the formula:

$$\sigma(c_i) = r_C(D) - r_{C-|c_i|}(D) \tag{11.2}$$

The results are as follows:

$$
\begin{aligned}
\sigma(c_1) &= 0.7500 - 0.6250 = 0.1250; \\
\sigma(c_2) &= 0.7500 - 0.5625 = 0.1875 \\
\sigma(c_3) &= 0.7500 - 0.6250 = 0.1250; \\
\sigma(c_4) &= 0.7500 - 0.6875 = 0.0625 \\
\sigma(c_5) &= 0.7500 - 0.6875 = 0.0625; \\
\sigma(c_6) &= 0.7500 - 0.5000 = 0.1250 \\
\sigma(c_7) &= 0.7500 - 0.6875 = 0.0625
\end{aligned}
$$

Calculating the weight of each evaluation indicator:

$$\omega_i = \frac{\sigma(c_i)}{\sum_{j=1}^{n} \sigma(c_i)} \tag{11.3}$$

Calculating the normalized weight of each evaluation indicator based on the above formula (11.3):

$$\begin{aligned}&\omega_1 = 0.1667; \omega_2 = 0.2500;\\&\omega_3 = 0.1667; \omega_4 = 0.0833;\\&\omega_5 = 0.0833; \omega_6 = 0.1667;\\&\omega_7 = 0.0833\end{aligned}$$

Competency model describes the company's core capabilities and personnel's core competencies and skills. These will be applied to recruitment selection, potential evaluation and the final appointment or removal decisions to provide more personnel's support for enterprises' better development.

11.4 Conclusion

With the gradually in-depth study of competency, the new human resources management mode based on competency will further enhance the core competitiveness of enterprises and provide a solid basis for enterprises in the fierce market competition. In this paper, it started from the characteristics of R&D personnel, combining with various methods to structure the R&D personnel's competency model, and forming its evaluation indicators system, further based on rough sets determining the weight of the evaluation indicators to ensure the rationality of evaluation system, then future providing reference for in-depth study of R&D personnel's competency. But, in the process of doing empirical research, the test methods of competency model need to be further expanded.

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Chapter 12
Demonstration Analysis on Effectiveness of Coal Resource Integration in Shanxi Province

Lei Tong, Xue Peng and Xu-lu Zhang

Abstract As the pilot province of coal resource integration, Shanxi Province has implemented the integration since 2004, consequently, local economics, mining security, utility of resources and the environment, to some extent, have influenced by the integration more or less. This paper carrying about correlation analysis on Shanxi coal industry concentration ratio, profit rate, million tons death rate, mining residue emissions per ten thousand tons and extraction rate by SPSS software, confirms that there are highly correlated relations between the degree of concentration ratio and local economics performance, mining security performance, utility of resources, at the same time, the environmental issues are gradually improving. The paper concludes with the problems of the integration of coal resources and the countermeasures.

Keywords Coal resource integration · Correlation · Countermeasures · Problems

12.1 Background Introduction of Coal Resource Integration in Shanxi Province

Shanxi is a rich-coal province in China, comparatively rich in coal reserves. The total coal resources accounted for 11.8 % of our country (5573.16 Gt). Since the 1980s, small mines in Shanxi Province were emerging continuously, up to more

L. Tong (✉) · X. Peng
Department of Business Administration, China University of Mining and Technology (Beijing), Beijing, China
e-mail: Tonglei91@126.com

X. Peng
e-mail: pengxue1207@yahoo.com.cn

X. Zhang
Department of Finance, University of International Business and Economics, Beijing, China
e-mail: tomxzhang@yahoo.com.cn

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than 10,000 wells. After merger and rectification in 1998, the number has been reduced to over 4,300, but only 321 wells have the output more than 30 million tons yearly, which occupied 8 % of the total (Li and Liu 2010).

Ever since 2004, as the pilot province, Shanxi Province got fully attention, during five-year period (2005–2009), the central and Shanxi provincial government promulgated a number of proposals and approaches of implementation to the integration of coal resources. After the integration and reorganization, the coal industrial pattern as "big in amount, small in size, random organized" were made a fundamental change. Until 2011, there were over 1,500 wells small coal mines have been closed and 250 million tons backward production capacity has been eliminated in Shanxi Province, in the meantime, four production capacity of 100 million-ton and three 50 million-ton mining enterprises have been established, and production capacity of less than 300,000-ton coal mines have been all eliminated, while the retained mines have all achieved full-mechanized mining (Yue et al. 2006). This high intensity and wide influential integration, not only greatly increased the degree of coal industrial concentration, but also influenced, to a certain extent, the economic development of Shanxi Province, environmental resources, and mining security.

12.2 Demonstration Analysis of Coal Resource Integration

12.2.1 Relevant Indicator Data

1. Industrial concentration ratio (CR)

Industrial concentration in this paper take the raw coal output of top-five Coal Group in Shanxi Province (Shanxi Coking Coal Group, Datong Coal Mine Group, Jincheng Anthracite Mining Group, Lu'an Group, Yangquan Coal Industry Group) as the base (Lu and Hong 2008) (Table 12.1).

2. Profit rate (PR)

Overall, the profit rate of Shanxi coal industry is rising year by year (Table 12.2).

3. Million tons death rate (DR)

Being a coal-rich province, Shanxi Province's one million tons death rate (DR) was below the national level, especially after coal resource integration, in 2010,

Table 12.1 Unit: %

Year	03	04	05	06	07	08	09	10
CR5	28.56	28.18	37.53	40	40	39.47	46	57.65

Date resource: Coal industry yearbook, corporation website

Table 12.2 Unit: %

Year	03	04	05	06	07	08	09	10
PR	7.23	9.41	10.47	9.13	8.56	16.45	13.61	15.32

Data resource: Shanxi environmental protection bureau website

DR was dropped to less than 0.2. 70 % mine accidents are caused by illegal mines, after integration, DR of 2010 lower nearly 90 % than that of 2003 (Guo and Zhang 2011) (Table 12.3).

4. Mining residue emissions per ten thousand tons (RE) (Tables 12.4 and 12.5).
5. Extraction rate (ER).

12.2.2 Data Processing

Five factors (coal industry concentration ratio, profit rate, million tons death rate, mining residue emissions per ten thousand tons and extraction rate) correlation analysis (Table 12.6).

12.2.3 Analysis Result

Profit rate, million tons death rate, extraction rate and concentration ratio are highly correlated, the coal industry profit rate and coal industry concentration ratio are highly positively correlated, million tons death rate and concentration ratio are highly negative correlation. Establish linear regression equations with profit rate,

Table 12.3 Unit: person/million tons

Year	03	04	05	06	07	08	09	10
DR	1.1	0.98	0.90	0.85	0.75	0.42	0.33	0.19

Data resource: Shanxi coal information network

Table 12.4 Unit: tons/per ten thousand tons

Year	03	04	05	06	07	08	09	10
RE	3,135	2,101	2,017	2,032	2,193	2,514	2,484	2,466

Data resource: Shanxi environmental protection bureau website

Table 12.5 Unit: %

Year	03	04	05	06	07	08	09	10
ER	42.1	44.3	45.8	51.3	58.9	69.9	80.1	81

Data resource: Coal industry year book

Table 12.6 Correlation analysis

Correlation	CR	PR	DR	RE	ER
CR	1	0.680	−0.887**	−0.098	0.862**
PR	0.680	1	−0.896**	0.033	0.836**
DR	−0.887**	−0.896**	1	−0.033	−0.987**
RE	−0.098	0.033	−0.033	1	0.105
ER	0.862**	0.836**	−0.987**	0.105	1

** represent statistical significance at the 5 %.

million tons death rate, extraction rate, coal industry concentration ratio by SPSS software.

$$\mathrm{PR} = 1.542 + 0.68\mathrm{CR} \tag{12.1}$$

PR is profit rate of coal enterprises in Shanxi province, CR is industrial concentration ratio in Shanxi province.

$$\mathrm{DR} = 1.932 - 0.887\mathrm{CR} \tag{12.2}$$

DR is million tons death rate, CR is industrial concentration ratio in Shanxi province.

$$\mathrm{ER} = 1.33 + 0.862\mathrm{CR} \tag{12.3}$$

ER is extraction rate; CR is industrial concentration ratio in Shanxi province.

From Eqs. (12.1), and (12.2), concentration ratio increase one %, make profit rate to increase 0.68 %; make million tons death rate to decrease 0.887 %; make extraction rate to increase 0.862 %. Although increasing of profit rate influenced by various factors, such as, the external economic environment, tax policy, the technology improvement of exploitation and other factors. From 2008 to 2010, being levy heavy taxes, coal enterprises in Shanxi Province still maintain a profit margin of about 15 %, which shows increasing return to scale after the reorganization, was evident, and economic performance of coal resource integration was improved. Million tons death rate, as a main point of the safety factor in performance assessment in coal resource integration, is highly negative correlated with concentration ratio. It is mainly because after the merger and reorganization, some small mines that lack of safe production capacity was forced to close for rectification, the mine resume production must meet the national standard in safety production (Zhao and Zhao 2010). Extraction rate, as the resource utilization performance assessment factor, is highly correlated with industrial concentration ratio, this phenomenon can be attributed to the increasing in R&D and equipment investment after the scale economy, makes extraction rate significantly increased (Cai 2010).

Mining residue emissions per ten thousand tons, as the assessment factor of environmental effects has no obvious correlation with concentration ratio, but according to recent data, after the comprehensive coal resource integration in 2008, mining residue emissions per ten thousand tons turns on a downward trend.

Economic and environmental problems both have time lags, as coal resource integration is not yet over, effectiveness is not yet clear. Considering the good results obtained by the first stage, coal resource integration plays a positive role on economic, safety and environmental performance.

12.3 Problems and Countermeasures

12.3.1 Problems

1. The high cost of coal resource integration

The owners of small coal mines, take the opportunity of integration to raise the purchase prices, and the local governments also claimed compensation, which increased the cost of integration; the enterprise still need to pay taxes even it is upgrading the non-compliance mines into production a series of legal issues that appeared during the process of merger and reorganization, need to spend many additional costs, increase the costs of enterprises (Wang 2011).

2. Merged small coalmines left over numerous serious social problems

First of all, from the perspective of workers' employment, the exploitation of small coal mining was depends mainly on human resource, however, machine might take place the role of human in mining work after integration, which makes coal workers' relative surplus. Closing small mines would cause local unemployment of migrant workers, which lead to social problems. Secondly, seen from the perspective of local government tax, local government revenue mainly relies on the taxes of township coalmines, so that fiscal revenue would drop significantly after integration. Thirdly, analyze from environmental safety angle, after shut down small mines, the problem of surface subsidence, contamination of groundwater resources and other environmental issues will be left to local governments and people. Finally, the exit capital could also be a newly brought social problem. Most small scaled mine were run by private capital, the big amount of private capital which dropped from small mine industry must have effective guide, or it will cause a lot influence to nation economy if this kind of capital was invested in stock market and real estate market (Zhang and Ma 2010).

3. Management and cultural differences after integration

After integration, the middle management whom from preceding township enterprise will keep taking position in coalmine, thus might brought difference in management and culture within the township coalmine and state owned coalmine. Large-scale state-owned coal enterprises, with a strong sense of safety production, are more comply with the law, adhere to fair competition, and follow the company's strategy of sustainable development. In opposite, small coalmines, constrained by their size, have no long-term development vision and just focus on short-term interests.

4. Liable to create a monopoly

Monopolization caused by integration would be detriment to the orderly operation of market. The qualities of coal resources, even in the same area may different from each other and the price different significantly. Then some enterprises would seize high-quality mine to establish monopoly of high quality coal (Lu and Gao 2003).

12.3.2 Countermeasures

1. Enacting standards of relative integration approach

In the process of resource integration, there is prone to the phenomenon of black-box operation, and thus neutrally Valuation Company or expert's intervention is necessary. We need to develop a unified compensation standard and legislate relevant bills of integration as soon as possible, so that the coal resource integration has law to abide by. Meanwhile, the government department with responsibility of territorial resource management and coalmine safety supervision should strengthen the co-supervision of integrated coal mine; monitor the process of integration and standard operation.

2. The establishment of the exit mechanism of small mines

Establish full-scale exit strategy regarding for labor employment, local tax, environment protection and private capital re-allocation. We have to compensate unemployed migrant workers with a reasonable pension. The environmental problems, such as surface subsidence, need actively controlled, and the merger would assume responsibility to repair them. And then establish special fund for ecological and environmental remediation. Central government should launch effective regulation to guide the private capital into other yielding fields to support local development and coal mine related industry development.

3. Management and culture fusion

We should take establishing effective management and excellent corporate culture as an important part of daily operations in a company, and strive to improve the core competitiveness of an enterprise. Then respect for the culture of both sides. Implement management method in daily operation, focus on import of advanced management technology, and strive to improve the management skill (Chang 2009).

4. Establishing an effective market order

The action of integration will definitely lead to a structure change that coal market will be dominated by a limited number of coal enterprises. But, it is cannot just focus on the Shanxi Province, considering the whole country, the market share of large enterprises in Shanxi Province is not sufficient to directly affect the national coal market (Fan 2010). Therefore, the coal companies should broaden their outlook wide, and try to make enterprises bigger, stronger and international.

12.4 Conclusions

Considering from economic, security, resource utilization and environmental perspectives, coal resource integration has made great improvement. After merging and reorganization, enterprises would produce scale economy and scientific management will improve innovation, thus, the competitiveness of the coal industry would be improved, and the companies embarked on an "intensive, large-scale, mechanized, information-intensity" management road. Management will be more standardized, information will be more transparent, and companies will also invest more money to improve safety production, reducing the mortality in mining by changing exploitation way to mechanization. Meanwhile, extraction rate will further improve, and the service life of the mine would be extended. Enterprises will implement in strict accordance with the national pollution emission standards to reduce the pollution of environment.

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Chapter 13
Empirical Analysis About the Promotion Effect of Financial Intermediation on Science & Technological Innovation

Wei Wei

Abstract Financial intermediation plays a great important part in science and technology innovation. We construct a financial intermediary model to analysis its effect to science and technology innovation. We get data from science and technology district in Peking, Tianjin, Hebei. And we use panel data unit root test and the panel data co-integration to examine the relationship between innovation and the support in the finance in small business enterprise in three districts. Research result shows finance intermediation has relation with technology innovation in different district. We suggest establishing the financial reform area. Encouraging civil capital getting into finance service realm is necessary. We should open folk's investment outlet and improve small tiny business enterprise.

Keywords Data co-integration · Financial intermediation · Science technological innovation · Unit root test

13.1 Instruction

Finance is a core of modern economy. It is an important mechanism to lead to economy resources allocation. Finance become the core of modern economy with strongly coagulate and permeate dint. Finance intermediation include the bank finance and non-bank finance medium which includes commercial bank, Stock Certificate Company, insurance company and information consultation service organization etc. In the modern market economy, finance activity has close relation with economy circulate. The scope of finance and the quality of the activity

W. Wei
School of Management, Hebei University of Technology, Tianjin, China

W. Wei (✉)
The People's Bank of China Shijiazhuang Central Sub-branch, Shijiazhuang, China
e-mail: weihappy2000@163.com

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directly influence the results of economic activities. Almost all finance activity are put into practice with the center of financial institution. Therefore, finance medium occupy very importance of position in the economic activities. Along with economy finance is turned continuously deepen and the degree with economy globalization is pushed forward, finance medium become the very complicate system. In addition, this system of operation condition has extremely importance of function for economy and society of health development.

Financial Intermediation which is a indispensability part of finance system, play a important part in science and technology innovation. Its function cannot be under estimated particularly for our country regard bank as principle of margin system. It caused the capital creation mechanism come forth because of various finance existence, which just make currency capital smooth ducting arrive industry capital circulation, satisfy the need of funds to economy growth. Financial Intermediation activity increased quantity increment to the whole national economy and adjusted saving quantity. Financial Intermediation activates financial market, in the meantime, activate whole society economy. Financial Intermediation wealth in the finance of value appearance and right are removal from various real object appearance which make thus society wealth can flow with the form of sign expediently, and make resources allocation acquired infinite extension of possibility, allocation of the efficiency get biggest exaltation, whole society of resources allocation real got into an efficiency ages.

Shumpeter (1934) point out "innovation" is a new "combination" of an entrepreneur production factor and produce condition, a process of import produce system to acquire the "exceed profits". Innovation is importance push strength when economy breakthrough grows. The key of economy development lies in innovation. The good bank provide fund to those most have ability of new product development to promote science and technology innovation. Financial Intermediation's service has played an importance part in science and technology innovation and economy growth.

Get into 20th century 90's, the scholar abroad started carrying on a substantial evidence research in the function of the bank and the capital market in science and technology innovation, and emphasized finance system exaltation whole main factor rate of production. King and Levine (1993) consider, the finance system identify enterprise of having the foreground, and enlarge the loan of these item and business enterprises funds which support and provide numerous risk dispersion outlet for it to promote science and technology innovation. Based on the theories analysis, they made use of 80 nations of 1960–1989 years and the front-panel data of the developing country analysis the relationship of finance and whole main factor. Research result show the extension of scale of finance intermediation and the development of function not only promote capital formed, and stimulate the exaltation of whole main factor productivity and long-term economy growth. And the beginning level of finance development can also explain the difference of all countries economy growth level (1960–1989). Finance development is the reason, whole main factor productivity of exaltation, long-term economy growth is the result. Levine et al. (2000) research validates the contribute of finance to long-term economy growth lies in exaltation whole main factor rate of production, not the save quantity in capital. World Bank's finance and growth: turbulence under the condition of policy choice (2001) also indicate finance to long-term economy growth of contribute mainly lie in exaltation whole main factor rate of production. There are also abroad scholar make a research from the tiny view angle in recent years on finance to business enterprise (particularly small business enterprise) innovation activity. Aghion et al. (2005) analysis the influence of finance control to fetch to abroad advanced technology. Alessandra and Stoneman (2008) analysis the EU second time and three time innovation common body investigate data to analysis the finance function in England innovation activity. Research result is finance have importance influence to innovation activity, particularly to high technology industry and the smaller scale business enterprise. Luigi et al. (2008) use 1990's Italy business enterprise innovation data to research the influence of the development of district bank to business enterprise innovation activity. Research indicates the development of the bank influence the business enterprise (especially high technology enterprise innovation) and the development of banking cause the enterprise to reduce (especially small business enterprise) sensitive degree flow.

13.2 The Analysis of Mechanism to Promote Science and Technology Innovation by the Finance Intermediation

13.2.1 Finance Intermediation has Carry out the Integration of the Funds Flow and Logistics and the Information Flow Efficiently With Match

Information revolutions cause innovation and proliferation, development and fusion to provide economy development of new path behavior type. The result of finance innovation is finance medium's permeate ability is stronger, and whole society economy of finance get consumedly exaltation. Finance intermediate's development makes funds flow not only match the logistics and information flow, and still promote the development of the real economy. What exactly "third-grade" integrate make social resource carried on integration and allocation in most valid and fast way, and getted into a new of development era.

13.2.2 Financial Intermediation Makes the Resources' Allocation Efficiently

First, the existence of various finance intermediation causes the creation of capital mechanism, which makes currency capital smooth participate in industry capital circulation satisfy economy growth to the need of funds. Finance intermediation's activities increase quantity increment to the whole national economy. Financial intermediation activates financial market and the whole society economy in the meantime.

Second, Financial intermediation peels of the wealth of value appearance and right from various real object appearance and makes finance property coupon, which make society wealth can flow with the form of sign expediently.

13.2.3 Finance Intermediate Saves Trade Expenses

System of evolvement is a continuously process of saving trade expenses. The existence of finance intermediation is a key core that saving expenses. Mankind economy development is the history which continuously carries on technique and system innovation to reduce cost and trade expenses, and enhance economy efficiency.

Currency is a key role in the process of the extension of the business enterprise scale. Finance intermediation organization—bank's birth improves money market efficiency and reduces the expenses of trade. But bank's indirect financing scale is limited, which can't satisfy the demand of business enterprise development. The dummy level of national economy nowadays is more and higher, which have more relationship with the lower trade expense.

13.3 Model and Data Instruction

13.3.1 The Model Establishment and Variable Enactment

Investigation innovation produce of devotion and output, usually use C-D function to analysis. We use it for reference of innovation activity, and join the finance system factor variable to set up model.

$$P_{it} = c + \alpha FIR + \beta slr_{it} + \gamma hr_{it} + \lambda ci_{it} + \varepsilon_{it}$$

1. We choose "patent application quantity P" to represent independence innovation ability. In order to reduce influence of square, we draw "patent application quantity P" from logarithms, get P, which is independence innovation ability variable.

2. We use Goldsmith conceived finance related ratio FIR to measure finance intermediation organization's development level. The FIR index of Peking City statistics annual, Tianjin City statistics annual, Hebei statistics annual is calculated for 2006–2011 years. The concrete calculation formula is: FIR = the loan and save surplus amount of the financing institution/GDP.

3. The variable of finance intermediation's efficiency.

The ratio of save with loan is the description of efficiency that is finance medium transform save into loan. This ratio can examine finance intermediate's work efficiency and reflect reflection finance intermediate's funds allocation ability. We use slr_{it} to denote it.

4. Science and technology innovation devotion quantity index.

We use science and technology movable personnel number to reflect science and technology innovation human resource devotion. We use hr_{it} to denote it and use ci_{it} to represent science and technology budget expenditure of the small business enterprise. In order to reduce square influence, we do logarithms index sign of the independence innovation devotion quantity sample data.

13.3.2 Data Elucidation

This text research is from 2006 to 2011 years. The data come from China statistics annual (2011), China science and technology statistics annual (2011), China finance annual (2011), China intelligent property right annual (2011) and Peking City (Peking statistics annual 2011), Tianjin City (Tianjin statistics annual 2011), Hebei of statistics annual (2011).

13.4 Empirical Analysis

The unit root of panel data and cointegration test theory can avoid problem of setting up a mold directly which may create false return. This paper first carries on a unit root test. We research long-term balanced relation of the variables. If each variable is not the same rank cointegration then we no longer carry on cointegration test. We use Eivews software to carry on a calculation processing.

13.4.1 The Unit Root Test of Panel Data

To carry on an unit root test (Fuerst 1999) mainly is for the sake of test quantity of steady to assure each variable whether same rank cointegration I(1). There are a lot of methods of the unit root of the panel data test. Each method has its advantage and bad situation. In this paper, we use the LLC, Fisher-ADF and IPS three kinds of test method to test the level variable of the panel data and the steady of a rank bad cent variable. The test result is as Table 13.1.

Table 13.1 The result of panel data unit root

Distract	Variable	Test method			Steady
		LLC test	Fisher-ADF test	IPS test	
Peking	P_{it}	1.6130	0.2524	−0.0524	No
	ΔP_{it}	−6.0922*	−1.4251**	−8.0854**	Yes
	FIR	1.5076	0.0954	−1.1225	No
	ΔFIR	−11.3041*	−1.062*	− 9.405*	Yes
	slr_{it}	5.6621	2.0025	0.9568	No
	Δslr_{it}	−14.6885*	−7.5214**	−2.0052*	Yes
	hr_{it}	5.6686	0.6254	0.7782	No
	Δhr_{it}	−8.7524*	−1.8331*	−9.5742***	Yes
	ci_{it}	0.6550	0.2151	−1.7585	No
	Δci_{it}	−5.2152*	−3.5201*	−6.2234**	Yes
Tian jin	P_{it}	0.3765	0.2025	−0.0715	No
	ΔP_{it}	−7.4424*	−1.9216*	−8.5721*	Yes
	FIR	1.7452	0.4535	−1.2515	No
	ΔFIR	−13.2245*	−5.0812*	−9.0840**	Yes
	slr_{it}	0.8123	0.1351	−0.013	No
	Δslr_{it}	−13.5482*	−1.8546**	−7.2245*	Yes
	hr_{it}	2.4526	0.8525	0.9750	No
	Δhr_{it}	−8.3251*	−1.3524**	−9.0225*	Yes
	ci_{it}	0.7524	0.1305	−1.0812	No
	Δci_{it}	−5.1231*	−2.5485**	−6.7858*	Yes
Hebei	P_{it}	0.7535	0.2025	−0.1015	No
	ΔP_{it}	−6.8521*	−1.9015*	−7.4115*	Yes
	FIR	2.4775	0.4630	−1.9805	No
	ΔFIR	−15.2152*	−5.082*	−12.3382*	Yes
	slr_{it}	1.6325**	0.1026	−1.3245	No
	Δslr_{it}	−11.9523	−1.8975**	−9.1327*	Yes
	hr_{it}	2.3950*	0.8605	0.2135	No
	Δhr_{it}	−8.2305	−1.3527**	−9.2468*	Yes
	ci_{it}	0.4525	0.1203	−1.4520	No
	Δci_{it}	−5.1300*	−2.5786**	−6.5458**	Yes

Note *, **, *** mean to statistics a value in 10 % respectively, 5 % and 1 % markedly

From the Table 13.1 of calculation result, we can find 5 variables of each district through unit root test of LLC unit root test, Fisher-ADF test, IPS test. All those variables don't pass unit root of assumption. These variables are not steady. These variable's rank ΔP_{it}, Δ FIR, The Δslr_{it}, Δhr_{it}, Δci_{it} are all steady. From the above calculation result we can see, these variables are all to a rank list the whole I(1).

13.4.2 The Cointegration of Panel Data

Three district variables: independence innovation variable(ΔP_{it}), finance related ratio (FIR), finance intermediation's efficiency (slr_{it}), human resource devotion

Table 13.2 The regress result of panel data

Attributive variable Independent variable	FIR	slr_{it}	hr_{it}	ci_{it}	α	Hausman test
Peking	0.089041**	2.103526**	0.322154*	0.400725*	1.402125*	0
	(7.630515)	(6.129152)	(4.153336)	(1.595260)	(2.012358)	
Tian jin	0.051136***	2.569306*	0.490798*	0.758702**	1.745821*	0
	(2.991002)	(5.875002)	(1.138126)	(5.121535)	(2.815521)	
Hebei	0.021860*	0.935528*	0.399531*	0.688102**	0.411062*	0
	(1.035202)	(2.200521)	(2.797768)	(11.16570)	(3.012184)	

Note *, **, *** mean to statistics a value in 10 % respectively, 5 % and 1 % markedly

(hr_{it}), science and technology budget (ci_{it}) all have an unit root as I(1). Therefore, this five variables have possibility of cointegration (Ramani and De Looze 2002). We use return to the model. The result is as the Table 13.2.

The return result show related ratio (FIR), finance intermediation's efficiency (slr_{it}), human resource devotion (hr_{it}) is positive at 10 % marked level bottom. It shows each district finance medium and innovation human resource which can promote independence innovation. Innovation funds devotion can promote independence innovation.

13.5 Conclusion and Policy Suggestion

We get data from science and technology district in Peking, Tianjin, Hebei. And we use panel data unit root test and the panel data cointegration to examine the relationship between science and technology innovation and the support in the finance in small business enterprise in three districts. Research show finance Intermediation has relation with technology innovation in different district. The market level of Peking, Tianjin is high. Small and medium business enterprise is a lot and the scale is great in these districts. The activity of science and technology innovation is early. The system is mature. Technology innovation makes use of funds efficiently. But in Hebei, the step of small and medium enterprise in science and technology type independence innovation is later. The usage efficiency of loan is low. Science and technology innovation of the resource got full make use of. We suggest develop small and medium finance institution. Small and medium finance institution's scale is smaller. They are familiar with the circumstance of small business enterprise in science and technology type of the region. They would like to provide finance service for the small business enterprise of science and technology type. But big banks are more prone to big business enterprise loan. They don't wish to loan to medium small and medium business enterprise. In the meantime, difference finance policy should be implemented according to different region of finance ecosystem environment. We should establish the area of financial reform experiment. Encouraging and leading civil capital getting into finance service realm is necessary. We should open folk's investment outlet and improve small tiny business enterprise and "three agricultures" finance service and open the outlet widely of the business enterprise financing.

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Chapter 14
Gas Expansion and Development of Compressed and Cryogenic Technology Support

Rui-yuan Xu, Hong-fa Shi, Zi-lin Sun and Jun Xie

Abstract Along with the national energy structure adjustment, natural gas consumption has risen opportunities for policy,the market of national city gas, CNG and LNG has faced the rapid expansion of the development situation and domestic provinces and cities and developed counties and gas markets have been developed and underdeveloped counties competing development situation. The rapid expansion and development of compressed gas and cryogenic technology support has became an important measure of the current implementation of rapid market expansion and improving economic aggregate, while actively corresponding national energy called and producing huge social benefits.

Keywords CNG · Capital operation · LNG · Property rights link

14.1 Introduction

Domestic gas business development prospects are very broad and it is expected to scale domestic gas utilization will reach billion cubic meters in 2015 and the proportion of energy consumption structure is expected from the current 3.9 to 8.3 %. Therefore, it is necessary to the gas business as downstream of the West-East business chain extension and ancillary services and treat it as oilfield

R. Xu (✉)
Department of Electrical Engineering, Hebei University of Science and Technology, Shijiazhuang, China
e-mail: 591141082@qq.com

H. Shi
Huabei Oilfield Company, Cangzhou, China

Z. Sun · J. Xie
The school of economics and management, University Of Science and Technology Of Hebei, Hebei, China
e-mail: 1012823410@qq.com

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company diversified development of core business development, as the big oil field economy gross main business and industry to replace one of the important contents of the oilfield, can be based on the oil field and extension of social.

14.2 The Significance of Gas Expansion and Development

It becomes the important factor of economic and social development of a strategy for tackling climate change. The State Council has printed and distributed ""Twelve Five" to Control Greenhouse Gas Emissions Program of Work". The program has made clear to the national unit of gross domestic product in 2015 carbon dioxide emissions decreased by 17 % compared to 2010. It has proposed to the comprehensive utilization of a variety of control measures and strengthened organizational leadership and evaluation. In order to response to climate change policy system and further improve the institutional mechanisms, the further improve the institutional mechanisms, the greenhouse gas emission system of statistical business accounting has basically established and the carbon emissions trading market is gradually formed, It Actively develops a low-carbon energy, adjusts and optimizes the energy structure, promotes the use of clean coal and encourages the development and utilization of coal seam gas and natural gas. Non-fossil fuels in primary energy consumption ratio of 11.4 % based on ensuring the safety of development of nuclear power by 2015.

In recent years, the natural gas market of China in low-carbon economy is gradually warming up, natural gas consumption and growth rates have increased significantly. The average annual growth rate of China's natural gas consumption by 13 % from 2000 to 2005 and average annual growth rate of 20 % from 2006 to 2010. In 2010, rapid increase in China's natural gas consumption from 24.5 billion cubic meters in 2000 to 88.7 billion cubic meters (Gu 2004).

14.3 The Introduction of Compression and Cryogenic Technology

The main technical indicators: compressed natural gas, the pressure of 4 MPa, and economic transport radius of 100 km; 20 MPa high-pressure, economic transport radius of 300–400 km. Liquefied natural gas, cryogenic temperature of −160 °C, low temperature storage and transportation economic radius of 800–900 km.

14.3.1 Compression Technology

CNG is compressed natural gas. Natural gas by filling stations after pressure from the compressor, the pressure to 20–25 Mpa after high-pressure depth of

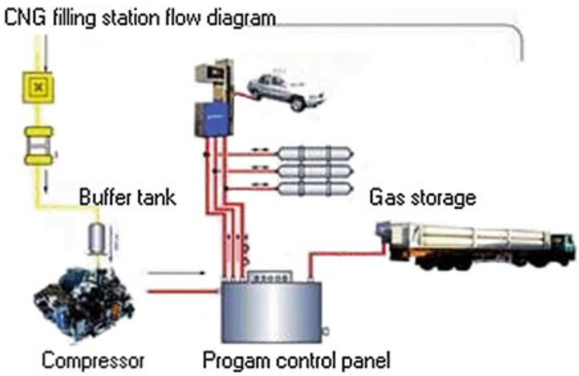

Fig. 14.1 Compressed natural gas supply process

dewatering, filling tank car storage of the high pressure cylinder group, and then transported to various cities to enter the pipe network to residential users, business users and user supply natural gas to industrial enterprises (Jingxin 2009).

CNG urban gas supply system by taking the gas point pressure station, CNG cylinder vehicle, town gas unloading station, urban pipeline network composition, process flow diagrams illustrated below (Fig. 14.1).

Natural gas by measurement, first into the purification device after the regulator, removal of water, hydrogen sulfide, carbon dioxide, to meet the standard requirements. Pressurized by the compressor to 15–20 MPa, inflatable pressure station of the high pressure hose and quick connector to the CNG cylinder vehicle, when the cylinder pressure reaches the set value, the compressor automatically shut down. CNG cylinder vehicle transported by road to reach the town to unload the gas station by the high pressure gas unloading station and the quick joints unloading gas, CNG first to enter a heat exchanger heating (to prevent natural and natural gas temperature drop through the regulator decompression large, the normal operation of the follow-up equipment and pipe network), re-entering a regulator decompression, followed by two heat exchangers, two voltage regulators, three voltage regulator, the pressure transferred to the urban pipe network operating pressure, metering, odorization into the urban pipeline network (Shi et al. 2012; CNPC 2005). Unloading gas installations, heating and regulating progression to the maximum working pressure should be integrated cylinder vehicle, unloading gas capacity of the regulating device, the urban pipe network design pressure and other factors to determine.

14.3.2 Cryogenic Technology

Large-scale gas transmission pipeline is the most economical and most effective method of transport. In addition, you can also use two other transportation methods. In addition to the previous section introduced the CNG compressed

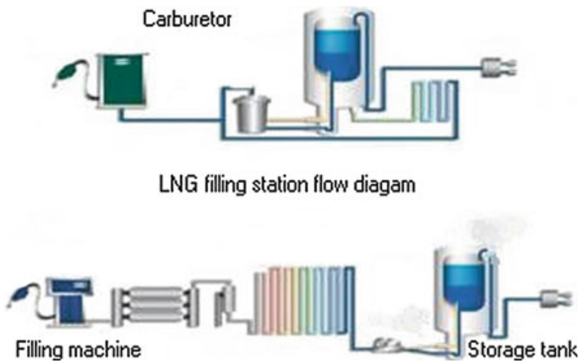

Fig. 14.2 LNG station car flow diagram

storage, there is another more effective delivery way LNG cryogenic liquefied storage.

LNG is a globally recognized clean energy, energy saving, environmental protection, safety, reliability, economic efficiency highlight a number of advantages. The so-called LNG is the English abbreviation for Liquefied Natural Gas LNG, translated into Chinese. Referred to as the LNG is a saying in English.

14.3.3 Access to LNG

LNG under low temperature, low pressure, liquid storage, transport and application, its density is about 620 times the gaseous, compressed natural gas, three times a single aerated sustainable travel 500–700 km, to meet the city bus, intercity bus long-distance heavy truck driving requirements and environmental protection, safe and reliable, has gradually become one of the main energy of the new energy market demand for China's automobile (Meng et al. 2009).

The main equipment of LNG station by low temperature storage tanks, LNG pump, LNG filling machine, saturation pressure regulator, unloading the supercharger, piping and accessories composition.

The main flow of LNG vehicle filling stations in the (Fig. 14.2).

14.4 Gas Expansion and Development of the Theory

14.4.1 Equity Financing Theory

The channels of corporate finance is divided into two categories: debt financing and equity financing. The former includes bank loans, issue bonds and notes payable, accounts payable, the latter mainly refers to the equity financing. Of debt financing liabilities to repay principal and interest agreed, creditors generally do not participate in the business decision, no decision-making on the use of funds. Of equity financing of own funds of enterprises, investors have the right to participate in the business decision-making, the right to obtain the dividends of the enterprise, but not to the withdrawal of funds.

The main advantages of equity financing: the financing to attract equity capital. Therefore, the corporate equity return of dividend even small spending pressures and enhance the ability to resist risks. If we can attract a strategic investor with a specific resource, you can also use the advantage of the management of strategic investors, financial strength, market channel advantages, the advantage of government relations, and technical advantages of the synergistic effect, the rapid growth of their own strength (Young in January 2004).

The biggest risk of equity financing is that the shares dilution may lose control of the company, part of the usufruct, or even in the corporate strategy and business objectives, management methods and new share holders have significant differences which led to difficulties in business as well as split.

14.4.2 Capital Operation Theory as the Core of Property Rights Link

Capital operation capital owners and their authorized representatives, optimize the allocation of its owned or managed by the factors of production to the form of value and rational flow, so as to achieve a management methods to maximize profits and to promote capital's largest value-added target the connotation of capital operation, capital operation principle is to ensure safety, efficiency and liquidity of capital.

Capital operation includes two levels: First, the micro-level, look at from the perspective of business management, and enterprise they have every resource, each of which factors of production are seen as added value requirements through a variety of management, effective way to achieve its profit and value-added goal of maximizing; macro-level perspective of a reasonable configuration from resource optimization, all social resources, factors of production as to add value the value to enter the market, with a value-added purpose and relationship to other capital elements, their added value depends on the degree of optimization of their entry into the capital structure, the various elements of this capital operation task is to unrelated organization to a specific capital structure, and optimize the capital structure, capital appreciation (Yu 2012).

The essence of property rights of capital operation as a link, to promote the optimal allocation of factors of production and reasonable flow to achieve maximum capital value-added target; the form of capital operations are diverse, both rely on capital markets, capital operation, there are capital market flow into the restructuring of the invisible market outside the capital and property rights. More common, including shareholding, joint ventures, mergers, bankruptcy, auction, sale, leasing, and the above manner is different, and its use due to the operation of different objects, the differences in subjective and objective conditions vary widely, and in the process of capital operation and display their talents (Li 2012; Sun 2004).

14.5 The Application of the Huabei Oilfield Company

14.5.1 Application Process

1. Through CNG and LNG technology widespread application, effectively expanding the gas business supply economic radius, realize the overall market layout of gas business. Hebei Oilfield Company gas business in accordance with the existing natural gas resources, and actively develop the gas source around the CNG and LNG filling stations in the market to drive in Beijing, Tianjin, Hebei, East China province, city gas development and utilization of the overall development of ideas, through wholly owned or joint venture to build station in the region of Central Hebei and Beijing, Tianjin formation of CNG, LNG and gas network; In the northern Hebei Province and Tianjin region, focusing on regional planning establishment of Binhai New Area and Tianjin Port to form a complete filling network; in the region of southern Hebei and Shanxi Jincheng coal bed methane as the core to the city bus, passenger, freight lines the main line, the radiation filling network of Shanxi, the whole territory of the South Area; vast region in eastern China, Jiangsu, Zhejiang, Anhui and southern regional focus on the formation of LNG filling network, then radiation the Huadong five provinces and one municipality. It is on the basis of the widely used CNG and LNG technology, making the gas business based in North China, the National Radiation, "the overall layout of the market is able to start (Sun et al. 2006).

After the statistics, as of the end of 2011, the target market in the operation of door station 4, station 13, is nearly 1,000 LNG car with gas service.

2. Through equity financing to complete the integration of interbank absorb advantages funds, and grow the strength of enterprises. As of the end of 2011, through equity financing working capital soared from 200 million yuan to 10 yuan, to achieve a combination of complementary resources and capital laid an important foundation for the realization of mutually beneficial cooperation and win–win development.
3. Through the capital operation, the establishment of cooperative relations, property rights as a link to achieve a comprehensive in-depth development of the gas market. To carry out gas business at the beginning of, facing the situation is all a city and most of the county level city pipeline gas and CNG market has saturated, the LNG as an emerging business although the market

potential is tremendous, but LNG business investment is large and the new energy understanding and recognition degree is insufficient, the market development work is very difficult. Through capital operation, the introduction of a number of capital market advantages, or government policies advantage of strategic partners to achieve a powerful combination of complementary advantages, so that the gas business to open up the situation quickly. A few short years, the establishment of the nearly 60 equity firms, pipeline gas, CNG and LNG business throughout the country, has successfully achieved the secondary development of both market and the strategic layout of the new business market.

14.5.2 Program Effectiveness Evaluation

2011, Huabei Oilfield annual sales of nearly 800 million cubic of natural gas; more than one million tons of sales of liquefied petroleum gas; sales of nearly 100,000 tons LNG; achieved operating income of nearly $ billion; net profit of a billion dollars.

Placement effectiveness is obvious. The 2011 total gas business staff of nearly 2,000 people, more than 2-fold increase over 2010.

The contribution to the society gradually. The annual fees and taxes, to break through 100 million yuan, grow 20 % than 2010.

Annual sales of natural gas, CNG and LNG can reduce carbon dioxide emissions of 319.55 million tons, and have a huge “reduction” benefits.

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Chapter 15
Industry Technology Road-Mapping Research Based on XRWS System Approach

Rui Tong and Congdong Li

Abstract This paper proposes a new system approach called at "(Tong)Xueli-(Xiao)Renli-(Zhi)Wuli-(Xing)Shili", establishing industry technology road-mapping system emergence model based on this new approach, trying to improve and develop. Wuli-shili-renli system approach proposed by Gujifa, an excellent outcome emerges when used in industry technology road-mapping based on this new system approach.

Keywords Industry technology road-mapping · System approach · XRWS · WSR

15.1 Introduction

In the 1950s, system engineering approach was developed so fast and widely used in many areas, mainly because of problem solving of complex engineering project organization and management, this methodology focuses on work processes and the way of thinking, as well as mathematical modeling and quantitative analysis. However, too much quantitative analysis and heavy mathematical modeling appears to be helpless when dealing with some complex problems. In 1980, IIASA organized an international forum, which was titled as "the reflection on system analysis process". Some famous experts on operation research and system analysis around the world attended this forum, and most of them argued that some complex problems in social and economic fields could not be solved by quantitative analysis

R. Tong (✉)
College of Management & Economics, Tianjin University, Tianjin 300072, China
e-mail: tongrui@jnu.edu.cn

R. Tong · C. Li
School of Management, Jinan University, Guangzhou 510632, China

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and mathematical modeling, but by the combination of qualitative and quantitative method (Gu and Tang 2007).

In 1994, Gujifa visited the center for system research of Hull university, U.K. and he met Doctor Zhu Zhichang who was conducting some system approaches research at that time, during his 2 months stay in the U.K, they exchanged and proposed an oriental system approach (Wuli-Shili-Renli-WSR) (Gu and Zhu 1995).

Technology road-mapping is considered to be an open complex system, its development process is complex system modeling. Industry technology road-mapping is a complex, conceptual model that is built by expert's view integration through workshop, its process is learning process, knowledge sharing process, and also a complex system modeling (Tong et al. 2010). Its development process, follow up, update and implementation afterward are highly relevant with WSR system approach, therefore, TRM complex system modeling based on WSR system approach can be considered one of the TRM development theory foundation.

TRM is developed by a group of experts during workshop, but it is a challenging task if it would be implemented afterwards. On the basis of WSR system approach, this paper proposes a system emergence model called TRM based on XRWS system approach, suggesting that Xueli should be added to original system approach (WSR) in order to formulate more perfect oriental system approach (XRWS).

15.2 The WSR Problems of TRM Follow-Up, Update and Its Implementation

Industry technology road-mapping is a complex, conceptual model that is built by expert's view integration through workshop, its process is learning process, knowledge sharing process, and also a complex system modeling (Tong et al. 2010). From the perspective of open complex system, technology road-mapping can be considered to be an open complex system.

According to WSR system approach, there are following seven steps (Gu and Tang 2007): (1) understanding intent; (2) establishing goal; (3) investigating & analysis; (4) formulating strategy; (5) selecting alternatives; (6) realizing idea; (7) coordinating relations. These steps might not be conducted by strict 1–7 order, for example, step 7 (coordinating relations) can be in the process from step 1–7. But every step must include WSR system thinking.

1. Understanding intent

Wuli: Try to understand the intent and significance of developing technology road-mapping, as well as some resources needed. Technology road-mapping should be a project that is driven by innovation, partnership, R&D efficiency, and government investment decision. In this step, sector study must be conducted in order to understand current industrial development situation, barriers and its future development direction, including its vision and mission (Tong et al. 2010). This step focuses on TRM database in order to prepare system modeling.

Shili: Understand project goal and try to link some important elements, some activities like project plan development, including project budget, schedule, work process, and system analysis and integration should be done in order to improve project effectiveness and efficiency.

Renli: TRM stakeholders should be identified in order to set up expert committee and develop relevant communication plan.

2. Establishing goal

Wuli: Based on step one WSR system approach, list all of the feasible goals and develop some relevant project plans, including project goals, evaluation standard and some constrained condition.

Shili: In the TRM project plan, tradeoff some goals, priority and weight in order to develop further project plan.

Renli: All TRM stakeholders including expert teams, government department, industrial association, should be identified and communicated by all kinds of communication plans.

3. Investigating & analysis

Wuli: Obtain all the materials and information about project and set up database, sector study, etc.

Shili: Based on the information obtained from Wuli, trade off some relations, constrained condition and goals.

Renli: Identify main decision makers and some impact factors, and conduct some cost-benefit analysis.

4. Formulating strategy

Wuli: In the technology road-mapping process, different workshops can be conducted for different strategy analysis.

Shili: Integrate all goals framework and technical support, and draft out technology road-mapping, figuring out performance indicators and offer some actual alternatives.

Renli: Develop all kinds of communication plans for different decision makers, in order to make sure project implementation easily.

5. Selecting alternatives

Wuli: In terms of initial alternatives, figuring out necessary supporting data and conduct data analysis of technology strategy in technology road-mapping.

Shili: Design and select suitable system model in order to integrate all kinds of relevant physical model for path selection and project selection.

Renli: In terms of all kinds of strategy of system model, identifying the interests, needs and viewpoints of stakeholders.

6. Realizing idea

Wuli: In terms of all kinds of available alternatives, making best use of project management tools, ideas and application.
Shili: Monitoring, evaluating and controlling project implementation.
Renli: Focusing on coordination and communication of different stakeholders.

7. Coordinating relations

Wuli: Coordinating, resources allocation, smoothing, and optimization.
Shili: Coordinating all kinds of goals, strategies, and alternatives with system practical environment, modeling and knowledge.
Renli: Coordinating and communicating with different stakeholders.

15.3 "Xueli" in TRM and System Approach

"Xueli" refers to the principles and rules of scientific research, and also to a scientific theory that is abstracted from actual practice and can be used to guide practice.

Industry technology road-mapping is a powerful strategy planning tool that can be used to boost technological innovation and obtain competitive advantage, so, it is highly significant to conduct relevant research and establish TRM theory accordingly (Tong and Li 2011).

It is blind practice if there is no theory, and it is hollow theory if there is no practice, although many kinds of management tools or other discipline theories can be used in technology road-mapping development, but there is still lack of relevant theory to support TRM (Phaal and Muller 2008). Therefore, it will be more significant in theory and practice if Xueli is added into WSR system approach.

This paper proposed (Tong)Xueli-(Xiao)Renli-(Zhi)Wuli-(Xing)Shili system approach, see Table 15.1, "Tongxiaozhixing" means better understanding of the combination of theory and practice, which means "Zhixingheyi" in Chinese.

15.4 Industry Technology Road-Mapping System Framework Based on "XRWS" System Approach

The driving force of developing TRM covers several aspects, like innovation in industry, government R&D investment efficiency and some company development barriers (Fig. 15.1). TRM development starts with future market need in industry, and then the vision and mission of industry development should be identified and reached (Tong et al. 2010). Tong Rui, Li Congdong proposed a model of strategic vision and mission in the paper, explaining further the relationship between vision and mission, which is mutually interacted, aligned, promoted and pull–push

Table 15.1 XRWS system approach

	(Tong)Xueli	(Xiao)Renli	(Zhi)Wuli	Xing(Shili)
Objective	WSR rules and principles	Linkage between people and other systems	Objective physical world rules and regulation	Inner rules of objective matters
Focus	Scientific methodology	System thinking, holistic approach, art & human culture	What to do? Function analysis reductionism	How to do? Logical analysis, optimization analysis
Principles	Innovation, speculation, critical development	People oriented, harmony, holistic thinking	Rigorous, sureness, query.	Integrity, satisfaction and feasibility
Knowledge	Research logic, rules, regulation and philosophy as speculation	Art knowledge, behavior science Traditional chinese culture	Natural science	System science, management science, complex science

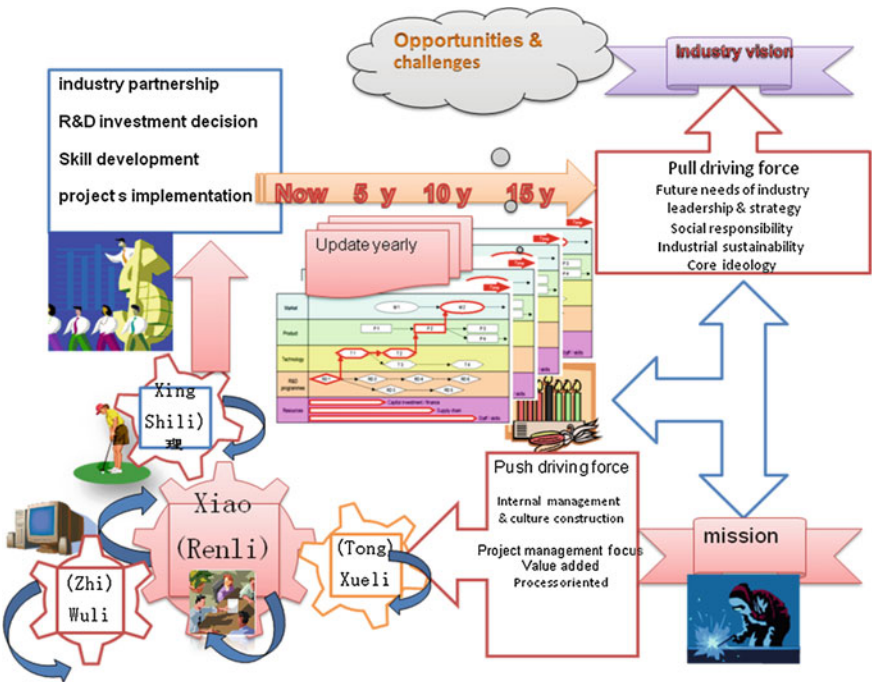

Fig. 15.1 Industry TRM system emergence model based on XRWS system approach

mechanism. As an external pulling force, strategic vision is highly relevant to leadership and corporate strategy, because organization leaders are usually much concerned about organizational vision, or future organization development direction, strategic planning. There must be some core ideas, including core objective or values if vision is formulated. Therefore, organization must be response to outside environmental change, some factors like social responsibility, industrial sustainability should be encapsulated into organization core values. In addition, powerful external pulling force should not be changeable once organization vision is formulated and fixed, however, organization strategy should be flexible and adapted to outside change, which means coping with shifting events by sticking to an unchangeable principle.

In terms of internal organization, mission is something like a powerful engine, which has strong pushing force, therefore, mission is determined by internal management and culture construction. Managers in organization are much concerned about organization process, project management efficiency and effectiveness as well as project management ideas and tools, in order to make sure every project should have clear link to organization strategy and have value contribution to organizational vision (Clifford and Erik 2006).

In order to improve industrial core competitive, and R&D investment efficiency, the vision and mission, this two lasting pulling-pushing driving force can boost industrial innovation by XRWS system approach, allocating all effective resources in industry, reaching all kinds of consensus through a series of TRM workshops, and finally industrial technology road-mapping with system emergence can be developed. In fact, system emergence in TRM development represents a strong core competitive, a lasting innovative and quick response to outside change ability, therefore, the main purpose of regular updating TRM is to accommodate outside market changes in order to adjust strategies, optimize resources and establish strategic partnership in industrial organization (Phaal et al. 2001, 2008).

In general, technology road-mapping covers following main contents (Industry Canada 2010): (1) industrial development vision and goals for at least 15 years; (2) what kinds of new type product or service are needed in future market? (3) what technology can support and create these products or services? (4) How about the feasibility of these technologies? (5) How about the alternatives of realizing these technologies? (6) What R&D projects should be developed to support these technologies? (7) what kinds of skills are needed to apply these technologies? (8) what kinds of educational programs are developed to support these skills or capabilities? (9) How to optimize limited investment resources from government? (10) How to establish effective strategic alliance mechanism in industry in order to realize future development vision.

XRWS system approach can be used in both TRM development and its follow up, update and implementation afterward in order to make sure TRM projects implementation.

“Tongxueli”: “Methodology is needed first if conducting self-innovation”, innovative methodology is fundamental of self-innovation. “Xueli” refers to scientific rules or principles, which means a methodology of solving problems, a source of creating knowledge and innovation. However, there is difference between methodology and method. Methodology refers a scientific system, a general process of dealing with problems, but “method” is an approach or a way of dealing with some matters. Technology road-mapping development include three phases (Garcia and Bray 1997), (1) preliminary activity; (2) Development of TRM; (3) follow- up activity. Methodology is something like TRM development process and complex system modeling, because Industrial technology road-mapping is considered to be an open complex system. “Xueli” thinking is very important and necessary in TRM development, “Tongxueli” means a better understanding of some scientific methods, a methodology oriented.

“Xiaorenli”: “Renli” focuses on communication, including interpersonal communication, personal to organization communication and organization to organization communication. So, “Xiaorenli” means identifying interests and needs of all stakeholders in TRM development, trying to meet their interests and needs, finally reaching all kinds of consensus for common goals. Therefore, “Xiaorenli” focuses on system thinking, integration analysis and traditional Chinese culture. “Renli” is typical complex system, which plays important role in TRM development and its implementation later, so, different communication plans are needed for all stakeholders.

“Zhiwuli”: “Wuli” refers to some rules and natural law of objective material world. The foundation of “Wuli” is usually natural science, including mathematics, statistics, modeling or some tools, “Zhiwuli” emphasize on reductionism, functional analysis, linear and logic thinking. Sector study is conducted before developing TRM, a great amount of knowledge can be obtained from internet, database, statistical year book and some publications. Some relevant knowledge should be mined before developing TRM in order to prepare modeling.

“Xingshili”: Shili refers to internal regulations of objective matter, focusing on how to do something. Therefore, the key point is how to conduct logical and optimizing analysis. On the basis of “Tongxue”, “Xiaorenli”, “Zhirenli”, the last one is practical activity, which means implementation., so, it is appropriate to call “Xingshili”, which means that “Xingshili” focuses on implementation process, action plan, and the effectiveness and efficiency of doing something. The knowledge that “Xingshili” will use is system science, operation research and management science. Its basic principle is system integrity, satisfaction and feasibility.

15.5 Conclusion

Linking “Tongxueli”, “Xiaorenli”, “Zhiwuli”, “Xingshili” together, the first character of each part can generate “Tongxiaozhixing”, which means better understanding the combination of theory and practice (Zhixingheyi in Chinese) in TRM development. According to ancient Chinese philosopher saying, theory and knowledge (Zhi) is important, but more important is how to take action (Xing), in that case, it is likely to generate system emergence (Shan in Chinese), Shan, in a sense, can also be called as core competitive, and final outcome of developing TRM is how to generate system emergence, which can then obtain core competitive.

"Tongxueli", "Xiaorenli", "Zhiwuli", "Xingshili", this XRWS system approach emphasize on better understanding of the combination of theory and practice (zhixingheyi). We believe that this new system approach not only can apply for TRM development, but also for some other fields, so, it is practical and valuable in future practice.

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Chapter 16
Institutional Development and Controlling Shareholder's Expropriation: Evidence from China

Wen-gui Li

Abstract This paper argues that the possibility of political extraction can influence the controlling shareholder's tunneling. We use the index of "relationship between government and market", which is from the NERI, as the measure of institutional development, and the samples are the listed companies in China during 2003–2007. The paper shows that, when the possibility of political extraction is high, firms controlled by the large shareholder who has a less separation of control rights and ownership rights hold less cash than other firms, and more expropriation by the controlling shareholder.

Keywords Cash holding · Controlling shareholder · Expropriation · Institutional development

16.1 Introduction

There is a growing empirical literature on the controlling shareholder's expropriation. For example, Shleifer and Vishny (1997) show that the controlling shareholder may use corporate resources to pursue their own self-interest, including diverting corporate resources for personal benefits at the expense of small shareholders; Wolfezen (1999) show that controlling shareholder can control the right of voting effectively by pyramiding or cross-holding; and Faccio et al.

W. Li (✉)
Economics and Management School, Wuhan University, Wuhan, China
e-mail: syswenwen@126.com

W. Li
School of Accounting, Zhejiang University of Finance and Economics, Hangzhou, China

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(2001, 2005) find that the features of "crony capitalism" are actually even more pronounced in Western Europe and East Asian economies, so the salient agency problem in these economies is expropriation of outside shareholders by the controlling shareholder.

According to agency theory, the controlling shareholder may choose to use corporate resources to pursue their own self-interest, including diverting corporate resources for personal benefits. There are many kinds of possible ways that controlling shareholder could use to exercise "tunneling", such as cash holdings, related party transactions, dividend policy, debt financing.

This paper evaluate whether institutional development can influence the controlling shareholder's expropriation behaviors. We examine the data of listed companies in China from 2003 to 2007. Just as Stulz (2005)'s view "'twin agency problems' that arise because rulers of sovereign states and corporate insiders pursue their own interests at the expense of outside investors", we mainly concerns the controlling shareholder's expropriation behaviors under different political environment.

In this paper, our objectives are two-fold. First, we investigate whether institutional development influences the impact of controlling shareholder on corporation's liquidity management. We find that companies in provinces with weak institutions tend to hold less cash. Second, we examine whether institutional development influences the controlling shareholder to occupy funds of listed company. We find that companies in provinces with weak institutions tend to be occupied more funds by controlling shareholder. These results reveal that controlling shareholder's expropriation can be reinforced by weak political environment.

The rest of the paper is organized as follows. In Sect. 16.2, we describe hypotheses based on theoretical discussion, and in Sect. 16.3, we describe the data and model. Section 16.4 presents the regression results, and in Sect. 16.5, we conclude.

16.2 Research Hypotheses

The agency problem between controlling shareholder and minority shareholders is mainly embodied in the reality that the controlling shareholder would seek personal benefits at the expense of minority shareholders. La Porta et al. (1999) and Claessens et al. (2002) find that the discrepancy between the controlling shareholder's ownership rights O and its control rights C has impact on the controlling shareholder's expropriation behavior. That is, the higher cash flow rights controlling shareholder has, the less embezzlement carried out by controlling shareholder, because this occupation may reduce its own utility.

The discrepancy between the controlling shareholder's ownership rights O and its control rights C may be amplified by pyramiding or cross-holding and the controlling shareholders will have greater motivation and opportunity to expropriate the interests of minority shareholders, which is referred as "Entrenchment effect". Ozkan and Ozkan (2004) shows that corporate cash holdings begin to decline when the manager' shares up to 24 %, and cash holdings begin to rise when the manager's shares up to 64 %. It is high agency cost that leads to the low corporate cash holding. He and Liu (2005) find that, due to the lack of protection of minority shareholder s' interests, and the absence of the market mechanism used to constraint the behavior of controlling shareholder, the tunneling phenomenon occurs frequently in Chinese capital market.

Cash is an asset with the strongest liquidity. Because it is very difficult for external investors to supervise, the cash is vulnerable to be transferred by insiders. Therefore, the controlling shareholder with high possibility of embezzlement could realize private benefits through transfer the listed company's cash flow, especially in environment with weak enforcement of property rights. For example, Caprio and Faccio (2011) find that firms located in provinces with weaker institutions hold less cash than firms located in provinces with stronger institutions. Based on above analysis, our first hypothesis is stated as follows:

H1: The lower possibility of controlling shareholder's expropriation, the higher firm's cash holding; however, when the firm is located in provinces with weaker institutions, the firm's cash holding will reduce while the lower possibility of controlling shareholder's expropriation.

Because government and corporate insiders pursue their own interests at the expense of outside investors, the listed company faces "twin agency problems" (Stulz 2005). The one is "the agency problem of corporate insider discretion". As insider, managers may take a variety of behaviors to maximize their own private benefits rather than the interests of outside investors. Another is "the agency problem of expropriation by the state". Government may use the powers to expropriate investors by actions ranging from outright confiscation to regulations that favor their own benefit.

The government expropriation may affect the controlling shareholder's interests. In order to reduce the risks of state expropriation and maintain his own interests, the controlling shareholder may take various actions, such as adjusting the corporation's investment policy and financing policy to increase their discretion and also make it harder for government to squeeze. In this case, the controlling shareholders become entrenched and can more easily take advantage of atomistic shareholders. Therefore, our second hypothesis is stated as follows:

H2: The lower possibility of controlling shareholder's expropriation, the fewer firm's funds be occupied; however, when the firm is located in provinces with weaker institutions, the firm's funds will be occupied much more while the lower possibility of controlling shareholder's expropriation.

16.3 Data and Methods

16.3.1 Data

Our initial sample includes all Chinese firms that are listed on the Shanghai or Shenzhen Stock Exchange during the period of 2003–2007. We eliminate firms with one of following features: (1) financial firms; (2) ST or PT firms; (3) firms that some data is unavailable or missing. At last, we have a sample of 4,807 observations. The data used in this paper includes three parts: the ultimate controlling shareholder data and the firm-level financial data are from the China Stock Market and Accounting Research (CSMAR) database. Following La Porta et al. (2002), we define the controlling shareholder as the shareholder whose actual ownership right over 10 % (La Porta et al. 2000). The institutional development data is from the National Economic Research Institute (NERI) (Fan et al. 2001).

16.3.2 Methods

In order to test the H1, the regression equation is set as follows:

$$Cash = \alpha + \beta_1 PoliticalE + \beta_2 Slevel + \beta_3 PoliticalE * Slevel + \beta_4' X + \varepsilon \tag{16.1}$$

Where *Cash* is primary independent variable, which represents the level of firm's cash holding. We compute a firm's cash holding ratio (Cash) as cash and short-term investment divided by non-cash assets (total assets minus cash holding) at the end of year t from 2003 to 2006, and as cash and cash equivalents divided by non-cash assets at the end of year t in 2007.

PoliticalE represents the institutional development level, which is measured by NERI index. NERI index of marketization captures the following aspects of regional market development: relationship between government and market; development of non-state business; development of product markets; development of factor markets; development of market intermediaries and legal environment. We use the index of relationship between government and market as the measure of institutional development. If the index of a province is above the sample mean value, we set *PoliticalE* equal to 1 and 0 otherwise. We expect that β_1 should be negative.

Slevel represents the possibility of controlling shareholder's expropriation, which is the separation level of controlling shareholder's control rights and ownership right. Therefore, we use the ratio O/C as the measure of the corporation's vulnerability to insider expropriation (Faccio et al. 2001). A low O/C ratio demonstrates the possibility of controlling shareholder's expropriation is high. If the O/C ratio is above the sample mean value, we set *Slevel* equal to 1 and 0 otherwise. We expect β_2 should be positive. According to H1, the coefficient of *PoliticalE* * *Slevel* should be negative.

We also include the following control variables that previous papers have found to be significant in tests of the trade-off of cash holdings (Opler et al. 1999). *Size* is the natural log of total assets at the end of year t and is taken as a proxy for firm size. *Control* is the nature of ultimate controller, and equal to 1 if the firm's ultimate controller is a national entity, 0 otherwise. *Lev* is ratio of debt to total assets. *Debt* is the sum of long term and short term debt at the end of year t. *CF* is the ratio of firm's annual operating net cash flow to total assets. *OF* is the change in net working capital, which is measured by the change in current assets minus current liabilities from year $t - 1$ to year t divided by total assets at the end of year t. *Growth* is calculated as the annual rate of growth of sales. *FA* represents the net capital expenditures in year t, which is measured by the annual rate of growth of fixed assets. We also include industry and year fixed effects in the tests.

In order to test the H2, the regression equation is set as follows:

$$OtherC = \alpha + \beta_1 PoliticalE + \beta_2 Slevel + \beta_3 PoliticalE * Slevel + \beta_4' X + \varepsilon \tag{16.2}$$

Where *OtherC* is the primary dependent variable, which represents the level of funds occupied by the controlling shareholder. It is calculated as the other receivables divided by total assets at the end of year t. The higher *OtherC* is, the more funds be occupied by controlling shareholder. According to H2, the coefficient of *Slevel* is expected to be negative and that of *PoliticalE* * *Slevel* should be positive. The definitions of *PoliticalE*, *Slevel* and *X* are consistent with (16.1).

16.4 The Empirical Results

16.4.1 Descriptive Statistics

Table 16.1 presents the descriptive statistics of the firm-level variables for the pooled sample.

The mean *Cash* is 20.59 % with standard deviations of 24.44 %, and the maximum value reached 466.95 %; the minimum value is 0. We find a great deal of variation in the *Cash*. It demonstrates that the phenomenon of high cash holding is relatively outstanding in Chinese stock capital during the sample period. Actually, many famous companies have been high cash holding since 2000, such as GM, IBM, and the companies' average cash holding rate is up to 17 % in United States (Opler et al. 1999). Some studies have shown that this phenomenon is a manifestation of embezzlement by controlling shareholders (Kalcheva and Lins 2007), but some other studies regarded the reason for high cash holdings as the precautionary motivation of firms, rather than management agency problem caused by separation of control right and ownership right (Bates et al. 2009). From the

Table 16.1 Descriptive statistics

	Max	Min	Mean	Stnd.Dev
Cash	4.6695	0.0000	0.2059	0.2444
OtherC	11.7180	0.0000	0.0665	0.3350
PoliticalE	1.0000	0.0000	0.4316	0.4953
Slevel	1.0000	0.0000	0.6724	0.4694
Size	27.6251	12.3143	21.4156	1.1087
Lev	9.7366	0.0081	0.5222	0.3356
CF	1.0690	−0.5708	0.0563	0.0891
OF	7.3631	−5.4285	0.0099	0.3227
Growth	77.8110	−1.0000	0.4168	2.6471
FA	31.3065	−2.1803	0.2285	1.2389

Cash is defined as cash and short-term investment divided by non-cash assets (total assets minus cash holding) at the end of year *t* from 2003 to 2006, and as cash and cash equivalents divided by non-cash assets at the end of year *t* in 2007. We use the NERI index of relationship between government and market as the measure of institutional development. If the index of a province is above the sample mean value, we set *PoliticalE* equal to 1 and 0 otherwise. *Slevel* represents the possibility of controlling shareholder's expropriation, which is the ratio O/C

perspectives of corporate governance mechanism and the tunneling behavior of controlling shareholder, Xin (2006), examine the problem of cash holding in Chinese capital market, and their results are in favor of the tunneling theory (Xin and Xu 2006).

The average value of *OtherC* is 6.65 % with standard deviation of 33.50 %, and its maximum value and minimum value are 1,171.80 % and 0 respectively, which shows the funds are occupied by controller of firms. The mean *PoliticalE* and *Slevel* are 0.4316 and 0.6724 with standard deviation of 0.4953 and 0.4694 respectively.

16.4.2 Institutional Development, Expropriation of Controlling Shareholder and Cash Holdings

The results in Table 16.2 show that there is a negative and significant association between firm's cash holdings and the possibility of controlling shareholder's expropriation. For example, regression (16.1) shows that, the coefficient of *Slevel* is 0.022, with a *t*-statistics of 3.142. While higher *Slevel* represents lower possibility of controlling shareholder's expropriation, the results are consistent with the first half of H1. From regression (16.2) we can find that the coefficient of *PoliticalE* is −0.043, with a *t*-statistics of −6.900. This result suggests that firm's cash holdings will be lower in the province with weak institutional development.

To assess whether institutional development can influence the controlling shareholder's expropriation behaviors, we augment our specification in regression (16.2) with an interactive variable *PoliticalE* * *Slevel*. As shown in regression

Table 16.2 Institutional development, controlling shareholder's expropriation and cash holdings

	(1)	(2)	(3)
Intercept	0.571***	0.623***	0.619***
	(8.669)	(9.442)	(9.349)
Slevel	0.022***	0.021***	0.026***
	(3.142)	(2.956)	(2.794)
PoliticalE		−0.043***	−0.036***
		(−6.900)	(−3.381)
*PoliticalE * Slevel*			−0.023*
			(−1.665)
Control	−0.008	−0.005	−0.005
	(−1.042)	(−0.643)	(−0.665)
Size	−0.016***	−0.018***	−0.018***
	(−5.237)	(−5.787)	(−5.768)
Lev	−0.100***	−0.102***	−0.101***
	(−10.761)	(−10.940)	(−10.897)
CF	0.409***	0.415***	0.414***
	(11.478)	(11.692)	(11.671)
OF	0.020**	0.019**	0.019**
	(2.074)	(1.972)	(1.989)
Growth	−0.000	0.000	0.000
	(−0.066)	(0.310)	(0.309)
FA	0.002	0.002	0.002
	(0.689)	(0.737)	(0.700)
	(0.689)	(0.737)	(0.700)
Industry	Yes	Yes	Yes
Year	Yes	Yes	Yes
Observations	4,570	4,570	4,570
Adjusted R^2	0.076	0.085	0.085
F Value	24.523***	26.117***	24.700***

Cash is defined as cash and short-term investment divided by non-cash assets (total assets minus cash holding) at the end of year *t* from 2003–2006, and as cash and cash equivalents divided by non-cash assets at the end of year *t* in 2007. We use the NERI index of relationship between government and market as the measure of institutional development. If the index of a province is above the sample mean value, we set *PoliticalE* equal to 1 and 0 otherwise. *Slevel* represents the possibility of controlling shareholder's expropriation, which is the ratio O/C. *, **, *** denotes statistical significance at the 10 %, 5 %, and 1 % levels respectively. The sample period is from 2003 to 2007

(16.2), the interaction term between institutional development and the possibility of controlling shareholder's expropriation has significance of 10 %, and its coefficient is −0.023. This result demonstrate that the firm's cash holding will reduce while the lower possibility of controlling shareholder's expropriation, if the firm is located in provinces with weaker institutions.

16.4.3 Institutional Development, Expropriation of Controlling Shareholders and Funds Occupation

Table 16.3 presents a regression of funds occupied by controlling shareholder on institutional development, possibility of controlling shareholders' expropriation and the interaction between these two variables (along with other controls). As we pointed out earlier, controlling shareholder's behavior will be affected by the political environment. As a consequence, the coefficient of the interaction item should be different with zero significantly.

Table 16.3 Institutional Development, Controlling Shareholder's Expropriation And Funds Occupation

	(1)	(2)	(3)
Intercept	0.737***	0.752***	0.760***
	(11.153)	(11.301)	(11.389)
Slevel	−0.005	−0.006	−0.015
	(−0.757)	(−0.812)	(−1.601)
PoliticalE		−0.012*	−0.026***
		(−1.908)	(−2.360)
*PoliticalE * Slevel*			0.020
			(1.533)
Control	−0.004	−0.004	−0.003
	(−0.584)	(−0.472)	(−0.430)
Size	−0.043***	−0.043***	−0.043***
	(−13.958)	(−14.068)	(−14.100)
Lev	0.496***	0.496***	0.495***
	(52.976)	(52.948)	(52.846)
CF	0.082**	0.083***	0.085***
	(2.290)	(2.334)	(2.367)
OF	−0.028***	−0.028***	−0.028***
	(−2.834)	(−2.866)	(−2.900)
Growth	−0.003**	−0.002**	−0.002**
	(−2.206)	(−2.099)	(−2.098)
FA	−0.006**	−0.006**	−0.005**
	(−2.222)	(−2.211)	(−2.140)
Industry	Yes	Yes	Yes
Year	Yes	Yes	Yes
Observations	4570	4570	4570
Adjusted R^2	0.426	0.426	0.426
F Value	212.865***	200.674***	189.712***

OtherC is calculated as the other receivables divided by total assets at the end of year *t*. We use the NERI index of relationship between government and market as the measure of institutional development. If the index of a province is above the sample mean value, we set *PoliticalE* equal to 1 and 0 otherwise. *Slevel* represents the possibility of controlling shareholder's expropriation, which is the ratio O/C. *, **, *** denotes statistical significance at the 10 %, 5 %, and 1 % levels respectively. The sample period is from 2003 to 2007

The results in Table 16.3 show that there is positive association between funds occupation and the possibility of controlling shareholder's expropriation, but it is not significant. We further control *PoliticalE* in regression (16.2), and its coefficient is −0.012, with a t-statistic of −1.908. The result suggests that firm's funds occupied by controlling shareholder will be higher in the province with weak institutional development. In regression (16.2), the interaction term between *PoliticalE* * *Slevel* is controlled. The coefficient of the interaction term exhibits positive sign, but the statistical significance is only about 12 %.

In sum, our results so far have documented evidence that the institutional development may influence the controlling shareholder's expropriation from listed companies in Chinese capital market, in response to the threat of political extraction. Specifically, firms located in provinces with weak institutions are subject to a greater likelihood of controlling shareholders' expropriation.

16.4.4 Robust Test

We check the robustness of the regression results by using other indexes to measure the institutional development. First, we employ the NERI index of marketization as a new measure. If the index of a province is above the sample mean value, we set *PoliticalE* equal to 1 and 0 otherwise. Second, we also use the data from the World Bank's report (2006) as another new measure . We take the following regions as low institutional development environment: northeast, northwest, central region and southwest. If the firm is located in one of these regions, the *PoliticalE* is equal to 1 and 0 otherwise. The results are similar to those reported in Tables 16.2 and 16.3.

16.5 Conclusion

This paper evaluate whether institutional development can influence the controlling shareholder's expropriation behaviors. According to agency theory, the expropriation of outside shareholders by the controlling shareholder has mainly come from the separation of ownership and control right. By a pyramid, cross-holding or reciprocal holding, the controlling shareholder got the control right of a listed company with few resources, and became the corporate insider with great discretion. Then, the controlling shareholder may choose to use corporate resources to pursue their own self-interest, including diverting corporate resources for personal benefits. However, controlling shareholder's behavior will be affected by the political environment. If the whole market environment is in a state of disorder, the government can use their power to maximize political interests, such as the cash flow tax, punitive forfeiture of assets and banning certain business activities or asking for bribes.

The results reveal that controlling shareholder's expropriation can be reinforced by weak political environment. First, we find that companies in provinces with weak institutions tend to hold less cash. Second, we find that companies in provinces with weak institutions tend to be occupied more funds by controlling shareholder. Our work has implications for the literature on controlling shareholder's tunneling behavior by bringing it to light that the institutional development may influence the controlling shareholder's decision-making.

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Chapter 17
Inward FDI's Impact on the Environment and the Countermeasures in Jiangsu

Hong-bing You

Abstract The paper analyzes the impact of environment regulation on FDI in Jiangsu. It puts forwards that the environmental regulations have a negative impact on FDI but the impact is not significant. Although FDI in Jiangsu mainly focus on the secondary industry, it is not obvious in high energy consumption and high pollution industries such as energy, construction, chemical and metallurgical. So, in short term, it will not cause direct environment pollution. Finally, it puts forwards the countermeasures to protect the environment when we attract the FDI.

Keywords ADF test · Cointegration test · Environmental regulations · FDI

17.1 Introduction

Since China opened to the outside, especially in the past decade, Jiangsu has attracted much more FDI than most of the areas in China. The FDI inflows have brought about profound impact both on the utilization of the resource and the environment in Jiangsu. However, different people have different opinion on the FDI's impact on the environment. They respectively use different theoretical logic to analyze the existence of positive or negative impact of FDI on the environment in the host countries, and offer foundation for policy decision making on FDI in

H. You (✉)
School of Economics and Management, Nanjing University of Science and Technology, Nanjing, People's Republic of China
e-mail: nustyou@126.com

H. You
College of Business Administration, California State University, Longbeach, Longbeach, USA

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developing countries. In this paper, cointegration test is mainly used to make empirical analysis on the relationship between environment and FDI so as to test the impact of the introduction of FDI on environmental pollution in Jiangsu.

17.2 Relationships Between FDI and Environmental Pollution in Jiangsu: Econometric Test and Result Analysis

17.2.1 Sample Selection and Data Description

We select data of solid waste, industrial waste and FDI in Jiangsu between 1987 and 2008. Combined with the actual situation of Jiangsu, the indicators measuring environmental pollution will be determined by the industrial gas (IG), industrial solid (IS). All statistics are from "Statistical Yearbook of Jiangsu Province".

17.2.2 Analysis of Statistical Indicators

The statistical data shows that the inward FDI has similar trend of growth and change with IG and IS. It shows that the long-term stable relationship may exist between them. In this paper, Augented Dickey-Fuller Test (ADF hereafter) and cointegration tests are made on foreign direct investment and indicators of environmental pollution (emissions of IG and IS) so as to determine the relationships between variables.

17.2.3 ADF Test

In real economic phenomena, the economic time series often have some common trends. Direct analysis without considering easily leads to "pseudo-regression phenomenon". So in order to obtain the internal economic relations, cointegration relationship test between variables and ADF are needed. It can be seen from trend figures in the previous chapter that most variables have common growth trend. For the subsequent analysis, we firstly have data process of FDI, IS and IG and make unit root test. The test results are shown in Table 17.1 (He 2010).

Table 17.1 shows that under the significance of 5 %, FDI, IG and IS are the random walk series without stability. Besides, there is unit root. After the once difference, the three series have passed stability test of the significance of 1 %. That means there is no unit root, indicating that the three series are ADF and represented by I (1).

Table 17.1 Unit root test on variables

Variables	ADF	Types	Lags	Critical value(1 %)	Results
LnFDI	−2.4841	TC	4	−4.4679	Unstable
△lnFDI	−5.3669	TC	4	−4.3669	Stable
LnIG	0.2606	TC	4	−3.7880	Unstable
△lnIG	−4.9031	TC	4	−3.8085	Stable
LnIS	−0.5300	TC	4	−3.7880	Unstable
△lnIS	−5.6624	TC	4	−3.8085	Stable

Use OLS to make a cointegration regression on lnIG and lnFDI, lnFDI and lnIS so as to get the cointegration equation:

$$\text{lnIG} = 6.9290 + 0.3807\ln \text{FDI} \tag{17.1}$$

(0.2869) (0.0482)
of which, $R^2 = 0.7575$ DW $= 0.3730$

$$\text{lnIS} = 14.2003 - 2.2450\ln \text{FDI} \tag{17.2}$$

(1.8925) (0.3177)
of which, $R^2 = 0.7141$ DW $= 0.6017$

Step 2: Generate the residual series of (17.1), (17.2) (Figs. 17.1, 17.2)

Step 3: It is known from the above analysis that the equation has autocorrelation. Use generalized difference method to eliminate autocorrelation and get the regression equation as follows.

$$\text{Order}\ \ Y = \ln \text{IG-0.8}\ln \text{IG}(t-1)$$
$$X_1 = \ln\ \text{YFDI-0.8 YFDI}(T-1)$$

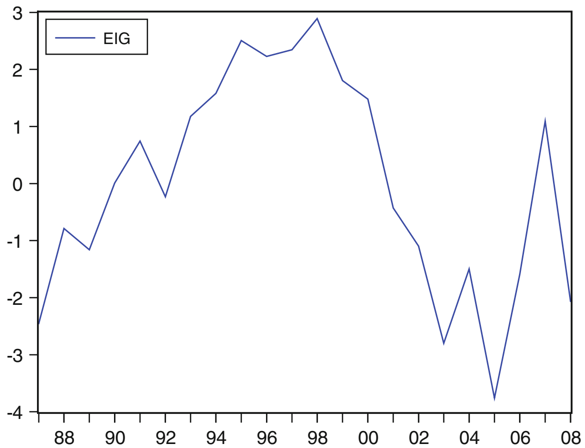

Fig. 17.1 The line of residual ε1

Fig. 17.2 The line of residual ε2

$$Y = 1.6492 + 0.1851X_1$$
$$(9.3991)\ (4.3611) \tag{17.3}$$

of which, R2 = 0.1206, DW = 1.3836

$$\text{order}\ \ Y1 = \ln\ \ \text{IS-}0.67 \ln\ \ \text{IS}(t-1)$$
$$\text{order}\ \ X2 = \ln \text{YFDI-}0.67\, \text{YFDI}\,(T-1)$$

$$Y_1 = 5.2298 - 2.4789X_2$$
$$(3.1799)\ (-3.2347) \tag{17.4}$$

of which, $R^2 = 0.3551$, DW = 2.0301.

Regression results after elimination of autocorrelation show that: DW is separately 1.3836 and 2.0301. The regression equation has eliminated autocorrelation, but goodness of fit in the equation is small. It may be due to the reason that data is too small, long-term elasticity coefficients of FDI on IG and IS are separately 0.1851 and −2.4789. That is to say, without considering other factors, every increase of 1 % FDI emission will promote 0.1851 % increase in IG and 2.4789 % reduction in IS.

Table 17.2 Residual ADF test (once difference series)

	Statistics of ADF test	1 %
LnFDI and lnIG	−1.98	−4.47
LnFDI and LnIS	−2.31	−4.47

If cointegration exists in two variables, the residuals ε calculated above should be stationary. Then ADF test is made and the results are shown in Table 17.2.

It can be seen from Table 17.2 that the test statistics −1.98 and 2.31 are smaller than the critical value −4.47 of the significance of 0.01. Neither of residuals of two models is steady, indicating that the series lnFDI do not have the cointegration with lnIG and lnIS. In fact, we could have seen from the regression equation that autocorrelation exists in residuals. We thus modify the regression model.

In summary, we can see from the above analysis, that FDI has no cointegration relationship with IG and IS.

The model that has conducted a generalized difference shows that without considering the influence of other factors, FDI has long-term stability with IG and IS. Every increase of 1 % FDI emission will promote 0.1851 % increase in IG and 2.4789 % reduction in IS. It may have relationship with the greater efforts the government has made with the industrial wastewater treatment. Now, with the advent of economic globalization, momentum of FDI in Jiangsu has increased, showing that FDI has partial impact on Jiangsu's environment, mainly in air pollution. Although FDI in Jiangsu mainly focus on the secondary industry, but it is not obvious in high energy consumption and high pollution industries such as energy, construction, chemical and metallurgical. So, in short term, it will not cause a direct environment pollution. However, once some electronic processing and manufacturing industries have formed into large scale, its pollution can not be ignored. In addition, much introduction of FDI in Jiangsu will also promote an increase in energy consumption and result in great pressure on the environment. Such results have much relationship with foreign direct investment, environmental control in local governments and the international background (Grossman and Krueger 1995; Zarsky 1999).

17.3 Countermeasures

From the above qualitative and quantitative analysis, we can see it more clearly that the FDI and environmental issues are mutually reinforcing as well as restraint. Our goal is to make coordinated development of economic development and environmental protection. Condition needed for achieving our goal is to deal with various problems between FDI and the environment. Government has a significant and irreplaceable role in environmental protection.

17.3.1 Suggestions on Environmental Regulations in Jiangsu

Environmental regulation is a powerful force to improve the environment. The development of a sound and reasonable environmental regulation has an important significance to attract FDI in Jiangsu.

1. *Improve the Policy of Levying Pollution Charges*

Damage of emissions on enterprises and the society are quite different. Companies need to pay for their pollution and pollutant charges are the costs they have to pay for their own emissions. This study shows that environmental regulations are not significant to attract foreign direct investment. So Jiangsu should continue to make efforts to increase environmental regulation. If charge increased by the Government is within the capacity that enterprises can afford, it will not have a greater impact to attract foreign direct investment.

2. *Improving Pollution Rights Market*

Emission trading is one measure for government to protect the environment. It is a limit set in a certain area. Companies in the region can only set emissions within the limits. Emission price is determined by the market mechanism and emission permits can be traded in the market. Government should improve the order of pollution rights market, measure and determine the capacity of regional pollution by monitoring, determine the level of pollution so as to provide the basis for local businesses to discharge pollutants, establish emissions trading platform, and prevent private trading. Besides, regions of poor environment are not allowed to purchase emission allowances from those of nice environment (Baumol and Oates 1988).

3. *Strengthen Information Disclosure and Public Participation*

Public participation will urge the Government to improve the environment, to improve the management, and to report and expose illegal businesses. Jiangsu should take effective measures to expand public participation in environmental management. First, to improve the environmental information disclosure. Second, to encouraging the development of non-governmental environmental protection organizations.

4. *Improving the Implementation of Administrative Enforcement*

We must improve environmental supervision and law enforcement. Government should firstly pay attention to it ideologically and continue to establish and improve regulations related to environmental protection, introduce policies promoting sound development of ecology, engage in staff training so as to improve their operational standards and enforcement capacity, take multi-sectorial linkage form of law enforcement from the multi-angle, multi-level of environmental management if necessary. Government should also set up a convenient channel for people to report so as to ensure multi-faceted collection of pollution control information. Moreover, relevant functional departments should increase penalties (Luo and Xu 2010).

5. *Multi-channel Funding for Environmental Protection and Efficient Use*

Adjusting water price is of one source for funding. Government can also get finance securities. They can get environmental technology funds with international community's support, and actively strive for technical and financial support in the environmental protection from the developed countries and international financial organizations, particularly a number of free transferred cleaner technology or pollution reduction technology (Bao and Hou 2010).

17.3.2 Proposals for Jiangsu to Attract Foreign Investment

1. *Establishing the Concept of Attracting investment with Sustainable Development*

The Government must firmly establish the concept of sustainable development as its economic core. The government should strictly scrutinize in attracting foreign investment, implement relevant policies and regulations such as "Catalogue for the Guidance of Foreign Investment Industries", "the Yangtze River Water Pollution Control Ordinance", prohibit application projects of foreign companies that may damage the ecological environment. In this regard, the government agencies must make good and previous judgment and investigation and resolutely have the future possibility of contamination nipped in the bud (Eskeland and Harrison 2003).

2. *Optimizing Industrial Structure of FDI*

It is time to orientate the FDI towards the advanced manufacturing and to orientate the FDI towards the high-tech industry (Bridsall and Wheeler 1993; Dua and Esty 1997).

3. *Reasonable Regard of Foreign Investment*

Our original intention to attract foreign investment is to improve the economy, which is a long-term work and should be measured from the developing and long-term perspective. And those behaviors of approval regardless of national foreign investment policies will make us to pay more in the future than what has benefited currently. We must put an end to short-sighted behavior, strictly abide by foreign investment approval procedures, amend current indicator that regards regional GDP as a performance evaluation, and introduce foreign capital truly beneficial for society (Daly 1982).

17.4 Conclusion

Based on the results of previous research, referring the background theory and econometric methods of "pollution haven" hypothesis, environmental Kuznets curve analysis, study of the relationship between FDI and environmental pollution in Jiangsu, then based on Theoretical and Empirical Analysis of the conclusions of Jiangsu Province, policy recommendations attracting foreign investment and environmental regulations are raised and main conclusions are drawn in the following:

Firstly, there are problems environmental regulations such as too many executive measures, lack of economic incentives, insufficient control of economic punishment in emissions, institutional problems of the source and use of EPA costs, unfinished implementation of local government policy.

Secondly, results show that the regression coefficient sign of environmental regulation stringency (lnXREGU), the main explanatory variable is negatively correlated the same as expected. But the coefficient (-0.35) is small, indicating that environmental regulations has a negative impact on FDI but the impact is not significant.

Thirdly, the model that has conducted a generalized difference shows that without considering the influence of other factors, FDI has long-term stability with IG and IS. Every increase of 1 % FDI emission will promote 0.1851 % increase in IG and 2.4789 % reduction in IS. It may have relationship with the greater efforts the government has made with the industrial wastewater treatment. Besides**,** the problem of FDI and environmental pollution is long-time and needs concern and further study.

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Chapter 18
IT-Enabled Enterprise Agility Based on Process Flexibility and Knowledge Sharing

Zhu-qing Yang, Hong Ling and Cheng Zhang

Abstract In hypercompetitive and turbulent environments, enterprise agility (EA) is an important determinant of firm success to achieve a competitive edge. EA is the ability of firms to accurately identify and understand opportunities and threats in the changing market, and to make quick and effective response to them by dynamically adjusting resources and processes. We explore the underlying capabilities that support EA which includes process flexibility and knowledge sharing, and explicate the enabling role of information technology (IT). In doing so, a framework of promoting EA is developed, that is, IT usage promoting EA by improving the ability of knowledge sharing and process flexibility. The framework and concepts in this paper are offered as foundational building blocks for the overall research program on IT-enabled EA.

Keywords Enterprise agility · Enterprise informatization · IT strategy · Knowledge sharing · Process flexibility

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Z. Yang · H. Ling · C. Zhang
School of Management, Fudan University, Fudan, People's Republic of China

Z. Yang (✉)
School of Business and Tourism Management, Yunnan University, Yunnan, People's Republic of China
e-mail: Yzhuqing@126.com

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18.1 Introduction

Today's business environment has become hypercompetitive and turbulent because of complex technological advances, shortened product life cycles, diverse customer requirements, and increased demand for product variety in fragmented global markets. In this condition, enterprises must be able to accurately identify and understand opportunities and threats in the process of market environment changing, and response quickly and effectively to them by making dynamic adjustment of their resources and processes. In turbulent markets, enterprise agility, which we define as the capacity to sense and response to capture opportunities more quickly than rivals do, is invaluable.

At the same time, information technology (IT) is increasingly been integrated into enterprises' production process, operations management and strategic management (Goldman et al. 1995). It has become an important tool and power driving them to continuously adapt to environmental change, and create competitive advantage. IT-based business intelligence is changing the decision-making of executives. IT applications and knowledge sharing is greatly improving the accuracy of the forecasts and the correctness of decision-making in enterprises.

Many scholars believe that IT should be as the main driving force and coordination tools for agile production, so it ensures that the enterprise can continue to survive and develop in the fierce competition (Sharp et al. 1999; Coronado et al. 2002). However, enterprise information systems are often not well adapted to the needs of the changing market environment, and allowed companies to track, respond to changes. They often make enterprises lost a lot of market share, even in the face of a crisis of survival. Although many studies has demonstrated the role of IT to improve productivity (Mahmood and Mann 1993; Bharadwaj et al. 1999; Banker et al. 1990), in-depth study of how IT to improve business agility is lack (Sambamurthy et al. 2003), especially literatures about the internal features of enterprise agility and how to access to it is very rare (Sherehiy et al. 2007; Bottani 2010). While the beneficial impact of agility is generally acknowledged, very little research exists to date addressing how an organization can achieve agility (Swafford et al. 2006).

By stressing organizations' initiative to adapt and change to the environment, this paper focuses on the problem of how to use IT to enhance business agility. We propose the model of IT-based knowledge sharing and process flexibility to promote enterprise agility. It expanded the current research scope of dynamic capabilities and competitive dynamic theoretically.

18.2 Theoretical Background

The original concept of agility was popularized in 1991 by a group of scholars at Iacocca Institute of Lehigh University in USA (Goldman et al. 1991). Subsequently, scholars in the field of strategic management, operations management and information management began to research it and notice the enabling role of IT in promoting enterprise agility (Tan et al. 2009; Van Oosterhout et al. 2006). The literature on enterprise agility has mainly focused on three aspects: roles and dimensions of agility, the relationship between flexibility and agility, and the impact of IT for enterprise agility.

18.2.1 Roles and Dimensions of Agility

Today's hypercompetitive environment is characterized by constant change and market unpredictability. Given these pervasive changes, successful organizations have to remain competitive while adapting to changing marketplace conditions. In general, an enterprise's agility directly impacts its ability to produce, and deliver innovative products to their customers in a timely and cost effective manner (Swafford et al. 2006). IT-enabled enterprise agility can eliminate non-value added activities, reduce manufacturing costs, improve customer satisfaction, and enhance competitiveness, and allows businesses to provide their customers with the right product at the right time (Lin et al. 2006). For example, Yahoo, Cisco and other companies are following with the development of IT technology, and continue to adjust its strategy to take advantage of business opportunities, and gain a great deal of success (Eisenhardt and Sull 2001).

According to the initiative degree of organizations responding to relevant change, agility could be graded. The taxonomical approach is Zhang and Sharifi's work (2007). They proposed an agile strategic framework that the agile strategy was divided into three categories: quick enterprise, responsive enterprise and proactive enterprises. The main features of the various types of enterprises, especially the driving factors and attributes of agility, were summarized in this literature. However, most of the existing studies ignored the relationship between the internal dimensions and elements of agility. Recently, Overby et al. (2006) noted that agile firms should respond appropriately to environmental changes in an appropriate manner at the right time. The degree of agility is dependent on the different combinations of sensing and responding capabilities that firms may possess.

18.2.2 The Relationship Between Agility and Flexibility

Flexibility is about the possibility of organizations coping with changes, but in contrast, agility emphasizes to accelerate the responding speed by reducing reaction time (Gunasekaran 1998). In addition, agility is not only the result of technological progress, advancing organizations, management structure and practice, but also the product of staff capacity, technology and motivation (Kidd 1995). This is one of the main differences between agility and flexibility in the business environment (Tsourveloudis and Valavanis 2002). In the manufacturing process, flexibility stresses operational capacity that transit from one task, production line, or state to another task, the production line or state; and agility is manufacturing capacity of the whole enterprise changing rapidly to the same target for adapting to and containing unexpected market threats and opportunities. Therefore, the scope of agility should be wider than that of flexibility (Tsourveloudis and Valavanis 2002). Time-based competition and flexibility are integrated in agility, that is, agility is a combination of speed and flexibility (Vastag et al. 1994).

A large number of researches have focused on the manufacturing flexibility in order to take advantage of flexible technology systems to resist uncertainties in the internal and external of organizations. However, in order to obtain more resources and capabilities than their competitors, enterprise must anatomize problems from a higher level outside of manufacturing flexibility and process flexibility, i.e., from the perspective of overall organizational agility. Unfortunately, there are no published studies in theoretical or practical literatures, to the best of our knowledge, which make attention to the question that the flexibility at operational level does not necessarily lead to the agility at the whole organizational level. Many literatures treat agility as an inevitable result of flexibility. Therefore, to distinguish between process flexibility at the operational level and organizational agility at the overall level, and to analysis the role of flexible process to enterprise agility and growth-promoting mechanism are important, and also academic and practical significance.

18.2.3 The Impact of IT for Enterprise Agility

Many scholars have linked IT with enterprise agility and pointed out that the IT enables enterprises to react quickly to changing market conditions. Agarwal and Sambamurthy (2002) discussed a number of organizational structures for the IT function observed in agile enterprises. They emphasized that managers should draw IT alignment with core business units, and that IT now plays a more prominent role in corporate agility. Weill et al. (2002) defines agility as a set of business initiatives an organization can readily implement. While making no claims of causality, they found significant correlation between strategic agility and IT-infrastructure capability. Burgess (1994) believes that IT and IT-enabled process is an effective tool for enterprise agility. Hovorka and Larsen (2006) point out that IT adoption and diffusion will promote business agility. Cao and Dowlatshahi (2005, 2006) analyze two factors of agility (Virtual Enterprise and IT), and emphasize the impact of the alignment of them on firms performance is more significant than the separate.

While IT is regarded as a powerful enabler of enterprise agility (Sambamurthy et al. 2003; Mathiassen and Pries-Heje 2006), a significant number of literatures have mainly described the agility framework theoretically (Sherehiy et al. 2007;

Lin et al. 2006; March 1991), but specific methods how firms access to business agility through IT usage have either not been empirically validated (e.g. Gunasekaran 1998), or are too abstract to offer specific indications for practical action (Tan et al. 2009; Zain et al. 2005).

By explaining how specific IT usage contributes to the development of various forms of knowledge sharing and process flexibility, and how combinations of each form of them can be leveraged for enterprise agility, the model developed in this article advances the state of existing knowledge by providing specific and testable propositions for attaining IT-enabled enterprise agility.

18.3 Promoting Mechanism of IT-Enabled Enterprise Agility

Enterprise agility consists of two components: sensing and responding (Sambamurthy et al. 2003; Overby et al. 2006; Lyytinen and Rose 2006). The former is the ability to aware and perceive environmental uncertainty, while the latter is the ability to reaction according with changes. Enterprise agility builds upon dynamic capabilities that pertain to firm success in turbulent environments (Overby et al. 2006). So, we propose the enterprise agility promoting model shown in Fig. 18.1, which is based on the Awareness-Motivation-Capability(AMC) framework (Chen 1996). In this model, IT usage improves knowledge sharing capabilities and processes flexibility of organization, thereby increasing enterprise agility. Among them, the level of knowledge sharing is the embodiment of organization awareness, reflecting its ability to aware and perceive changes; process flexibility is the manifestation of the ability of enterprises to cope with change; and the level of enterprise agility reflects the ability of enterprises to take corresponding action.

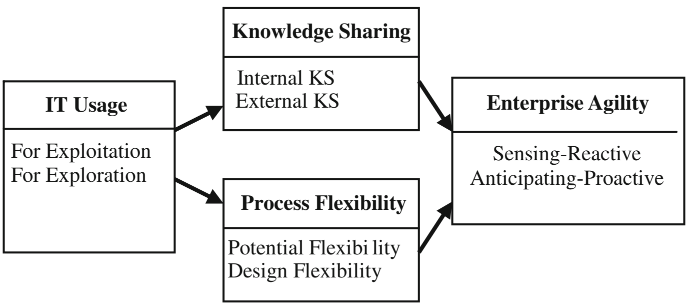

Fig. 18.1 Enterprise agility promoting framework

18.3.1 Concepts

The concepts of exploitation and exploration stem from organizational learning theory (March 1991), which are two types of the most basic organizational behavior. In the field of information management, Subramani (2004) divides IT usage into two complementary usages, that is, exploitative and explorative. The goals of IT usage for exploitation include improving, applying, and incrementally refining firm capabilities for clearly definable benefits (e.g., cost reduction, process consistency, process efficiency), which are derived from standardization, strict control, reducing manual intervention. The goals of IT usage for exploitation consist of creating new capabilities, devising novel solutions to current problems for soft benefits that are difficult to evaluate in advance (e.g., shared understanding, clearer picture of cause-effect relationships, greater understanding of operating environment). There are many examples of IT usage for exploration, such as analysis of point-of-sale data to understand patterns in customer preferences, patterns in the sale of complementary products, enhancing the communication of product designers and consumers to improve the attractiveness of new products, analysis of product-return data to detect issues to be addressed at retail store level (e.g., problems in handling, displaying products), and improving information sharing between suppliers and retailers to respond to market changes. Accordingly, IT usage for exploitation is corresponding with process digitization and automatization and used for structure and used for routine operational implementation activities, while IT usage for exploitation is corresponding with process informatization and intelligentization information and intelligent, and mainly used for unstructured and unconventional analysis of decision-making activities.

As for process flexibility, it can be divided into potential flexibility and design flexibility based on existence forms of flexibility (Gerwin 1993). Potential flexibility is inherent in the existing processes, shown under some given conditions. So, it is static flexibility. Design flexibility is the ability of organization improving the potential flexibility through re-configurating and re-designing processes when the amount of required flexibility is greater than the potential one. So, it is dynamic flexibility. One of the purposes of business process reengineering (BPR) is to expand its potential flexibility (Hammer and Champy 1993).

According to its scope, Knowledge sharing can be divided into sharing knowledge between different departments within the organization and sharing knowledge outside the organization about customers, competitors and technological progress.

Enterprise agility, according to its response to changes timely, is divided into reactive perception-responsive agility and proactive forecasting-initiative agility. The former is that organizations perceive and react passively only after the change occurs, while the latter is that they estimate and projection, and prior to be adjusted to take the initiative to respond to change based on historical experience and the accumulation of data before the change occurs.

18.3.2 The Influence of IT Usage on Enterprise Agility

IT and information systems are complex artifacts, which can provide users with a wide variety of functions. On the one hand, IT makes knowledge sharing among various functions of the enterprise, and then increasing the knowledge content of the various enterprise applications, and allowing companies to enhance the ability to learn, at the same time, to rapid and sensitive response in uncertain, changing competitive environment. On the other hand, information systems play the role to regulatory process, coordinate activities, improve process efficiency, and sort out, mine and synthesize knowledge related to operational activities. At the right time, they provide knowledge of internal collaboration and external changes in the market about customer demand and technological progress to managers who need, improve their managerial decision-making level and business innovation capacity of enterprises, and promote efficient cooperation among different functions. Therefore, IT usage can not only improve process efficiency but also enhance process flexibility at the same time (Lee et al. 1997), also make the enterprise more agile response to changes in internal and external environment. So, based on static contingency view and dynamic contingency view, we can make two following propositions.

1. Static contingency view is an expansion of the functional view of the biologist on 'life forms should adapt to the external environment', which views organizations as open systems. From this perspective, survival is the key target or primary task facing organizations, and environmental conditions are direct sources compelling organizations to change. So, managers should concern about 'good match' between the organization and its environment. As the basis of this theory, we propose:

Proposition 1 IT use for exploitation can improve sensing-reactive agility by enhancing the level of internal knowledge sharing and the potential flexibility of business process in the enterprise.

2. According to dynamic contingency, the difference of corporate performance is not only determined by their existing market position but also by the impact of long-term competitive activities in a fiercely competitive environment (D'Aveni 1994). So companies need to have dynamic capability, that is, capability of integrating, building, and reconfiguring their competitiveness to cope with change (Teece et al. 1997). Hrebiniak and Joyce (1985) and other contingency theorists firmly believe that organizational adaptability is a dynamic process subject to inspire by internal management and external environmental change. They propose that static contingency theory focused on the most effective match between the organization and its environment, but overlook the process to obtain match. As a result, emphasis on matching them will led to the organization's rigid and inert. IBM is too stressed mainframe to

adapt anything, while suffering a crushing defeat in opportunities exist in the development of the personal computer market to cede the most important market in IT industry's. So the matching of organization-environment should be a dynamic concept. Therefore, the dynamic Contingency emphasized: ① managerial options or strategic choices are the results of the connection between the organization and the environment; ② the ability to create, manage and understand organizational environment is that managers must master. According to this view, when the environment is constantly changing and increasingly unstable, enterprise agility based on operational flexibility could stabilize corporates' overall performance and increase the probability of their survival. Design flexibility of process reflects of enterprise capacity of initiative to change its internal inertia. Based on the theory of dynamic capabilities and organizational inertia perspective, we propose:

Proposition 2 IT use for exploration can improve Anticipating-Proactive agility by enhancing the level of external knowledge sharing and design flexibility of business process in the enterprise.

18.4 Conclusion

Literatures of strategic management have been assumed that the long-term competitive advantage is existence (Rumelt and Teece 1994), scholars have also done a lot of theoretical and empirical studies about the existence of long-term competitive advantage (D'Aveni et al. 2010). However, recent studies have begun to realize that, in fact, long-term competitive advantage is very few, and the duration of competitive advantage are becoming shorter and shorter (Wiggins and Ruefli 2002). In today's fiercely competitive environment, the vast majority of business success depends on a series of short-term, temporary competitive advantage (Wiggins and Ruefli 2005). So, along with the strengthening of market turbulence and competitive nature, the competitive environment requires for the level of enterprise agility becoming higher and higher. While different enterprises are with large differences in micro-environment, so to implement enterprise agility is highly dependent on the interaction between turbulence of environment and corporate capacity to respond it. On the other hand, although agility is very important for the enterprise in turbulent environment, it is not "free lunch", which requires investment in IT and complementary resources, and can not blindly pursue.

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Chapter 19
Modeling and Simulation of the Inter-Organizational Knowledge Transfer Impact Factors in Industrial Clusters

Ji Xiong, Zhao Duan and Yang Wang

Abstract Due to the rise of the knowledge economy, knowledge becomes one of the important required resources of the modern enterprise development and growth. When the enterprise cannot completely meet the demand of knowledge internally, it often transfers, shares and innovates knowledge to acquire external knowledge resources. This paper is to synthesize the related theory on industry cluster and knowledge spread, which starts from the process of diffusion of knowledge beyond the industrial cluster enterprise. According to the characteristics of knowledge alliance network, this paper utilizes the theory of system dynamics to analyze the causal relationship of knowledge transfer in cluster transfer, to analyze impact factors of inter-organizational knowledge transfer. Additionally, the simulation is realized through NetLogo software, so as to provide suggestions that how to improve inter-enterprise knowledge transfer.

Keywords Knowledge transfer · Knowledge innovation · NetLogo simulation · The industrial cluster

19.1 Introduction

In the cluster internal organization, enterprise obtained new knowledge through the innovation and development, a large part of which will be transferred out and become the whole enterprise cluster public knowledge. So how to realize effective

J. Xiong (✉) · Z. Duan · Y. Wang
Department of Information and Management, Central China Normal University, Wuhan 430079, China
e-mail: xiongji1987920@sina.com

Z. Duan
e-mail: victorduan@tom.com

Y. Wang
e-mail: cocotata@126.com

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knowledge transfer have become the key problems of cluster enterprise face. To realize the knowledge transfer, it is necessary to research and identification enterprise cluster factors affecting knowledge transfer. Domestic and overseas scholars research on the affecting factors of enterprise clusters' knowledge transfer from different angles, mainly concentrating in the knowledge itself, the characteristics of knowledge transfer party and knowledge receiver party (Davenport 2005). All these factors are likely to be a block or promote role to affect enterprise knowledge transfer.

But now these studies mainly lack of the study of knowledge transfer process of organization alliance and network outside the scope of relevant situation factors. Comprehensive and systematic analysis and arrangement, and quantitative research are relatively less (Nan et al. 2006). It is also short of integration of several effect factors of the model construction and research, with enough theoretical interpretation but few empirical studies. This study, begins with the knowledge transfer theory, in the cluster the network range, catches the key elements of the network, puts forward the key factors of influence of industry cluster enterprise knowledge transfer, and then gets the relevant hypothesis and the simulation results.

19.2 Introduction to the Theory

Industrial cluster refers that a large number of close-knit business and its supporting institutions gather in space beyond the specific area, and forms a group of competitive advantages (Sorenson et al. 2006). In order to access to new knowledge and new technology break down market barriers to reduce the cost of exchanges between enterprises to achieve economies of scale of the enterprise.

Researches on knowledge transfer discuss the factors affecting knowledge transfer and the internal mechanism on the basis of Nonaka SECI model and Szulanski exchanging theory. This paper studies the knowledge transfer of cluster enterprises belonging to the inter-organizational knowledge transfer; it contains explicit knowledge transfer and tacit knowledge transfer, divided into knowledge sharing and knowledge absorption (Bahlmann and Huysman 2008). Knowledge transfer relates to four factors: the sender of knowledge, the recipient of knowledge, the knowledge gap and the transferring knowledge.

19.3 Study on Influence Factors of the Knowledge Transfer Between Oraganizations

At present research on the organization of knowledge transfer effect factors can be divided into three main aspects: tacit characteristics, the receiving party characteristics and social network characteristics.

In tacit characteristics, the researchers acknowledge the fuzziness of complexity knowledge, knowledge distance and embedding of tacit knowledge and to the protection of the level and other factors will lead to the limits of the study and exploration, organization of knowledge transfer caused significant impact. Holtbrugge and Berg prove knowledge characteristics and influence of the source to the knowledge transfer with the empirical verification (Zhen 2007). Meanwhile, in the aspect of the knowledge distance and embedding, knowledge distance points to a similar with the recipient of tacit knowledge and the extent of the system. Peng Can redeems that knowledge transfer between different subjects needs overlapping of knowledge transfer knowledge to improve efficiency. Cummings and his fellows own an idea that embedding nature of transferring knowledge affects the difficulty of knowledge transfer. The deeper the knowledge embedded degrees, the more difficult the knowledge transfer. Tacit knowledge in the degree of protection, when knowledge related to the core competitiveness of the enterprise, to prevent their knowledge transfer to other enterprise, tacit enterprise will take the active preventive measures.

In the receiving party characteristics, research shows that the receiving party's "absorption capacity", learning culture and the receiving party motivation are important factors of inter-organization of the knowledge transfer (Guo and Guo 2011). Many researchers identity absorption ability is the key factor, Lane, Mowery, think absorption ability can strengthen the organization of the convenience of knowledge transfer, with recognition, absorption and using the three dimensions. Gupta, Szulanski think that absorption ability strengthens can promote the organization of knowledge transfer frequency and quantity. The receiving party motivation can be divided into learning, active and passive learning and interactive learning. Benjamin, by empirical study found that the league enterprise through to research and learning from each other can promote effectively the knowledge transfer (Kodama 2008). Osterloh think, tacit knowledge and its transfer are hard to be supervised and controlled through observations. So that it needs the intrinsic motivation to motivate employees to move such knowledge (Qinghua and Xiaobo 2002).

Social network characteristics research mainly starts from the duality theorem and the network level set out, emphasizes the social relationship resources embedding, connects around social situation and joins the scale to start. The main research focuses on the network node, networks and network structure three dimensions, most of the research on the social network analysis method and structural hole theory. Reagans and McEvily empirically research the connection strength, network density, network range of tacit knowledge to send the influence of ease (Feicheng and Xiaoguang 2006). Ahuja, Powell and others point that the agency is located in the center of the social network can improve the level of organization knowledge transfer. Ingram and Roberts empirically analyze the network density on the hotel manager knowledge transfer effect between the influence of performance and hotel. Hansen thinks that connection strength react the close degree among reaction organizations (Feng and Li 2006).

19.4 The Theoretical Assumptions and the Causal Analysis of Knowledge Transfer and Innovation

Through the inter-organizational knowledge transfer influence factors analysis, this paper concludes the factors influencing knowledge transfer, which mainly are transfer threshold, knowledge gaps, absorptive capacity, learning motivation and network scale and density.

Theoretical hypothesis:

H1 The knowledge gap between enterprises and the transfer threshold on inter-firm knowledge transfer innovation effect is positively related to

H2 The motivation for learning and absorptive capacity on inter-firm knowledge transfer innovation effect is remarkable positive correlation

H3 The scale and density of the cluster network on inter-firm knowledge transfer innovation effect is related to

On the basis of the above analysis and assumptions, we can use Vensim software to form the causal relationship of the knowledge transfer innovation between enterprises and have a model as is shown in Fig. 19.1.

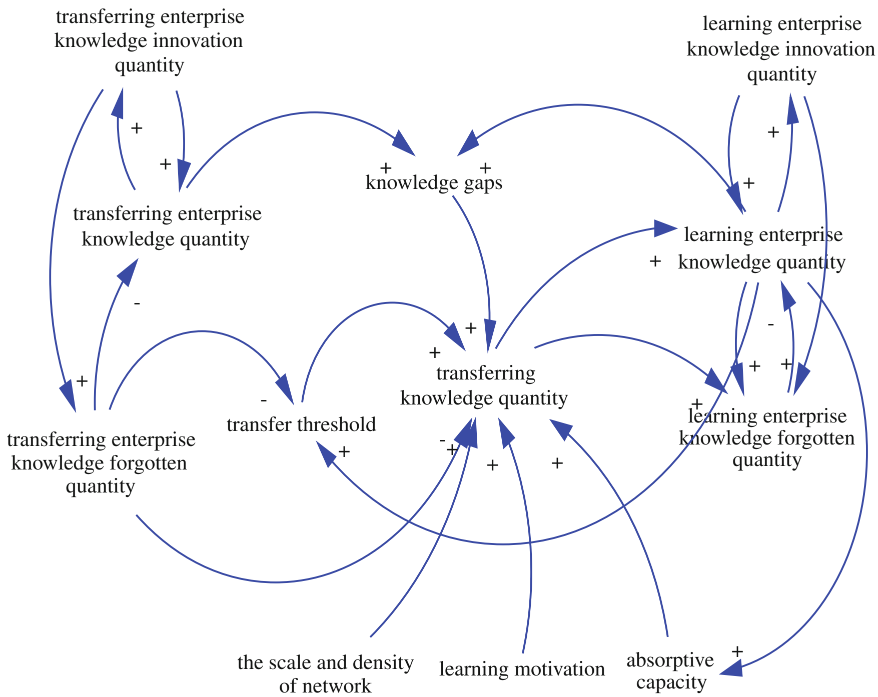

Fig. 19.1 The causal relationship of the knowledge transfer innovation between enterprises

The main loop:

(1) Learning enterprise knowledge quantity ↑→ Transfer threshold ↑→ Transferring knowledge quantity ↑→ Learning enterprise knowledge quantity
(2) Learning enterprise knowledge quantity ↑→ Absorption ability ↑→ Transferring knowledge quantity ↑→ Learning enterprise forgotten knowledge quantity ↑→ Learning enterprise knowledge quantity
(3) Learning enterprise knowledge quantity ↑→ Learning enterprise innovated knowledge quantity ↑→ Learning enterprise forgotten knowledge quantity ↑→ Learning enterprise knowledge quantity
(4) Learning enterprise knowledge quantity ↑→ Knowledge gap ↑→ Transferring knowledge quantity ↑ → Learning enterprise forgotten knowledge quantity ↑→ Learning enterprise knowledge quantity
(5) Learning enterprise knowledge quantity ↑→ Transfer threshold ↑→ Transferring knowledge quantity ↑→ Learning enterprise forgotten knowledge quantity ↑→ Learning enterprise knowledge quantity
(6) Transferring enterprise knowledge quantity ↑→ Transferring enterprise innovated knowledge quantity ↑→ Transferring enterprise forgotten knowledge quantity ↑→ Transferring enterprise knowledge quantity

Amount of transfer knowledge is influenced by five factors: transfer threshold, the knowledge gap, learning motivation, absorptive capacity and the scale and density of network. Transfer threshold embodies the transfer to the most advanced enterprise knowledge for the needs of the confidential. When the level of accepting enterprise is close to and transfer enterprise, transfer will no longer occur. Knowledge gap is knowledge distance. In the cluster inside, different enterprise knowledge level differ, thus in the enterprise he knowledge distance formed, and the existence of knowledge distance formed the main power by the cluster enterprise to obtain and transfer knowledge. Learning motivation manifested the will that the enterprise transfer knowledge, cooperation between enterprise and the trust relationship, communication between the two sides, the ideas of organization learning to solve the problem. Absorption ability is the ability that enterprises understand, digest and absorb the knowledge, and use for it. The scale of industrial cluster network is the number of network members, namely the number of enterprise network in industry cluster. Industrial cluster networks density is network communication and cooperation between enterprise and the number of actual happen with the network potential happened to the ratio of the maximum communication enterprises. If the ratio is bigger, the industrial cluster network density corresponding is higher.

19.5 Simulation

NetLogo is a multi-agent simulation model integration environment, especially suitable for complex system to model simulation. The main functions are modeling, simulation operating control and simulation output, which can directly system dynamics modeling simulation. If quantitative research inter-firms knowledge transfer dynamic behavior, we can use NetLogo simulating research the five factors in model: transfer threshold, the knowledge gap, learning motivation, absorptive capacity and the scale and density of network.

According to relevant factors hypotheses for specific model to the following description: in the cluster, enterprise be divided into three kinds, it is respectively: (1) A class (gray node): has the high level of total initial knowledge enterprise; (2) B class (red node): the total amount of knowledge, knowledge absorption ability and learning motivation is average enterprise; (3) C class (green node): some of the homogeneous knowledge enterprise, but the total amount of knowledge level is low. In the knowledge transfer process, the number of the C enterprise will significantly reduce, first turns into B enterprise and become the one with general learning ability. As the transfer continues, the absorption and learning of knowledge can help it become the A enterprise.

Three pictures were simulation clock in t = 0,100 and 450 we can see as the simulation clock push, the red node near the green node turns red, red node which get transferring knowledge began to become gray node. In the initial state, with the red nodes are more concentrated on the lower side region it gets the number of firms to transfer knowledge fastest growing. This is because of the enterprise from the nearby obtaining the knowledge is relatively easy (Fig. 19.2).

The simulation results and analysis:

1. Enterprise oneself behavior factors on the impact of knowledge transfer

Set: number-of-nodes = 80, average-node-degree = 8, initial-outbreak-size = 3;

① When absorption-ability = 40, learning-motivation = 30, knowledge-gap = 27, transfer-threshold = 0.5, 0.8, respectively corresponding to the moving and monitoring image is shown in Fig. 19.3.

When transfer-threshold is 0.8, the curve “a” rising and curve “c” falling in the steepness is significantly larger. So when a learning enterprise knowledge quantity and a transferring enterprise knowledge quantity is the closer, the faster the speed

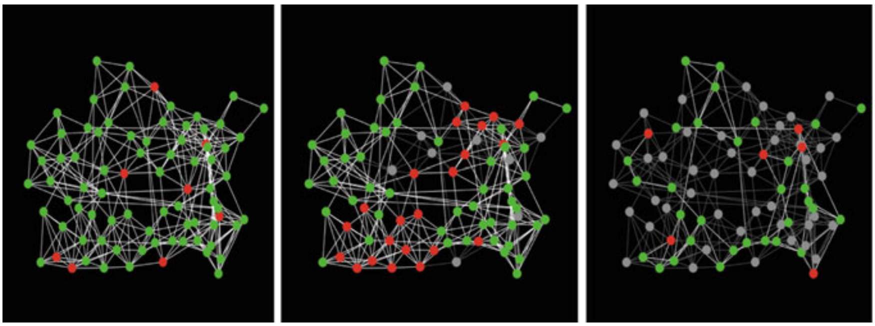

Fig. 19.2 Pictures were simulation clock in t = 0.100 and 450

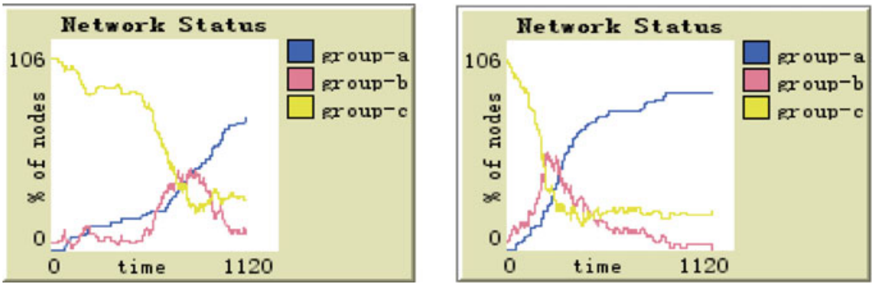

Fig. 19.3 When transfer-threshold = 0.5, 0.8, the moving and monitoring image

of knowledge transfers. The number of A enterprises increased significantly and the number of B enterprises rapid growth, the number from C enterprises into A enterprises increased significantly, it is conducive to knowledge transfer.

As time goes on, the threshold is 0.8, curve "a" and curve "c" have a slow growth and decline, then basically stable state, knowledge transfer is very slow, the number from C enterprises into A enterprises do not increase, until no further transfer. However, the final threshold is 0.5 and 0.8, A, B, C enterprises are in almost equal numbers. This shows that when the threshold value is close to 1, A enterprises in order to protect their tip competitive advantage in the knowledge, no longer transfer knowledge to C enterprises.

We can know the transfer threshold on inter-firm knowledge transfer speed have great influence, but the knowledge transfer quantity is not affected very much, and when the threshold is close to 1, not to transfer knowledge.

② When learning-motivation = 30, transfer-threshold = 0.5, absorption-ability = 40, knowledge-gap = 27, 45, 65, respectively corresponding to the moving and monitoring image is shown in Fig. 19.4.

In the case of the initial assignment of the same parameters, "a" curve shows upward trend, "c" curves down, and "b" curve first increase then decrease, and reach a value at steady state. The rise and fall of curve steepness changes slightly. It shows a certain knowledge gap can promote the occurrence of knowledge transfer, but no significant effect on the speed of knowledge transfer.

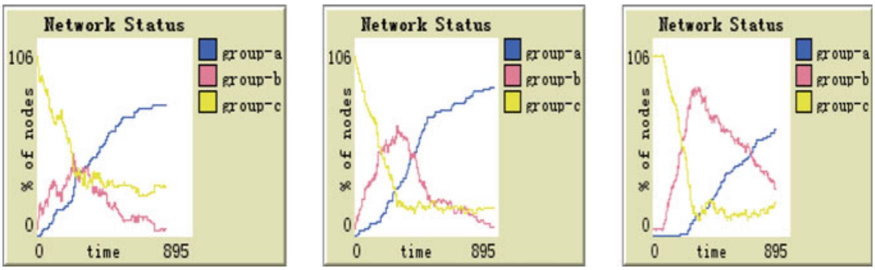

Fig. 19.4 When knowledge-gap = 27, 45, 65, the moving and monitoring image

Different values from the simulation curve to stable state level shows when knowledge-gap by 27 increases to 45,it achieve the balance state, the number of A enterprise grows and the number of C enterprise reduces. It show that with the increase of knowledge gap between enterprises, the number of enterprise acquiring, absorbing and transferring knowledge within a cluster grows, knowledge-gap by 45 increases to 65, the number of acquired and absorbed firms to transfer knowledge not only continue to increase but declined, to reach equilibrium, the Class A number of firms in Fig. 19.3 is significantly smaller than in Fig. 19.2 Class A number of enterprises, and Class C companies increased.

This could explain the knowledge gap not only has positive function driver on the knowledge transfer but also has the reverse side effect. With the increase of knowledge gap, the power to acquire new knowledge of cluster enterprise will also improve, so as to promote the knowledge transfer. However, if the large knowledge gaps exist, even the enterprise has knowledge transfer, it will also hinder the transfer of knowledge acquisition, absorption and utilization.

③ When absorption-ability = 40, transfer-threshold = 0.5, knowledge-gap = 27, learning-motivation = 25, 40, 50, respectively corresponding to the moving and monitoring image is shown in Fig. 19.5.

In the initial value of the same circumstances, with the simulation time increases, in the three pictures, knowledge transfer enterprise quantity is increasing gradually, but the increasing speed will decrease gradually, and eventually form a stable condition in a numerical. This shows that learning motivation has a certain impact on the knowledge transfer of cluster enterprises.

When learning-motivation from 25 to 40, 50 change, the higher learning-motivation the more within a cluster of enterprise knowledge transfer amount and greater value curve a steep rise, curve c sharp declines. When learning-motivation is 25, curve is rising and falling slowly. It shows in the case of strong learning motivation, knowledge transfer within clusters enterprise quantity increases the speed to be quick to transfer willingness weaker condition. But when learning-motivation is 40 and 50, the steepness of the curve is basically the same. But when value is 50, in a shorter time for 571 the simulation ends. So when learning motivation is stronger, the enterprise carries on knowledge transfer faster, at the same time by C, B enterprises into A enterprises the number is more.

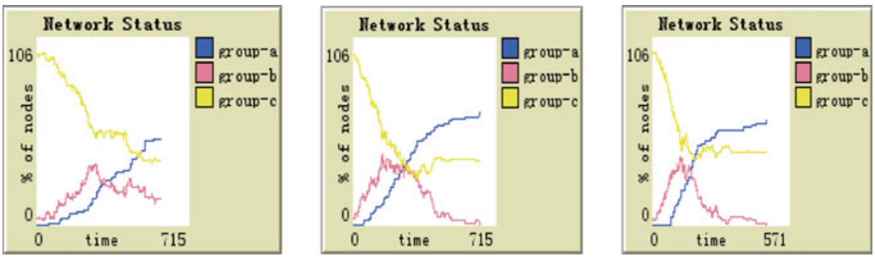

Fig. 19.5 When learning-motivation = 25, 40, 50, the moving and monitoring image

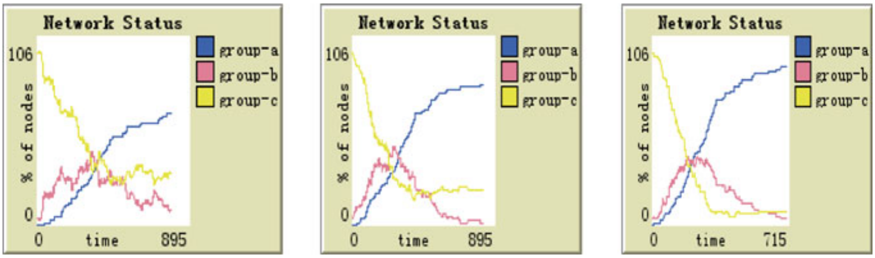

Fig. 19.6 When absorption-ability = 30, 50, 80, the moving and monitoring image

Therefore, stronger the learning-motivation of knowledge accepting enterprise is, faster the knowledge transferring speed is,the transferring effect is better. It is that learning-motivation and knowledge transferring of enterprises in clusters had a positive correlation.

④ When learning-motivation = 30, transfer-threshold = 0.5, knowledge-gap = 27, absorption-ability = 30, 50, 80, respectively corresponding to the moving and monitoring image is shown in Fig. 19.6.

By above three images, it is known that absorption ability for knowledge transfer in different enterprises has the same positive correlation as the learning motivation of knowledge. When enterprise absorbing ability is higher, the knowledge transfer speed faster, and in the curve up-down speed is faster, in the same time the number which C, B enterprise transfer into A is more. When absorption-ability greatly increased to 80, the simulation in time 715 ends, finally the quantity of A enterprise is more and C enterprise is less than value for 30, 50.

It implies that stronger the knowledge absorption ability is, the knowledge transfer effect a cluster is better. When absorbing ability is stronger by a large margin, the absorption and affection to transfer knowledge is improved significantly.

2. The influence of the network in clusters to knowledge-transferring

Set: transfer-threshold = 0.5, knowledge-gap = 27, learning-motivation = 30, absorption-ability = 40;

① When the average-node-degree = 8, initial-outbreak-size = 3, number-of-nodes = 40, 180, respectively corresponding to the moving and monitoring image is shown in Fig. 19.7.

The increase of the network scale negligible impact on the effect of knowledge transferring motivation in different enterprises. But due to the increase in the number of enterprises, the network topology structure complexity increases, enterprise knowledge transfer will been slow down.

② When number-of-nodes = 80, initial-outbreak-size = 3, average-node-degree = 5 or 60, respectively corresponding to the moving and monitoring image is shown in Fig. 19.8.

When the network density increases, the industry networks in cluster contact more closely, communication between enterprises more, knowledge acquisition

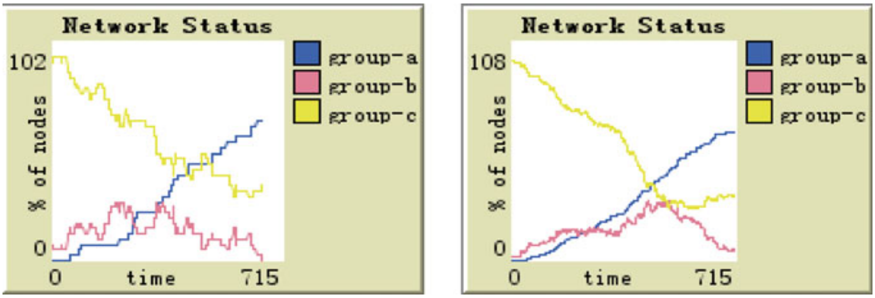

Fig. 19.7 When number-of-nodes = 40, 180, the moving and monitoring image

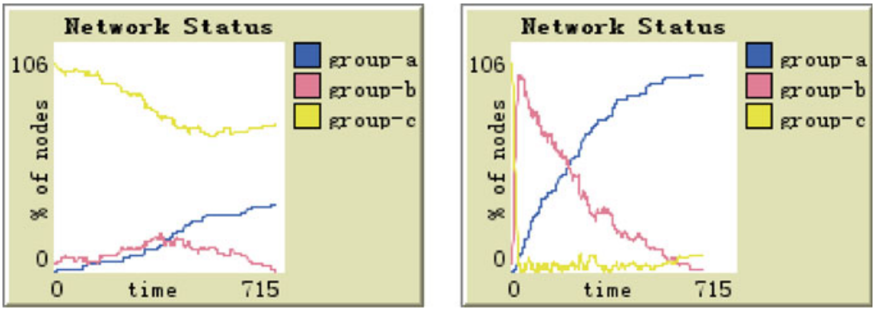

Fig. 19.8 When average-node-degree = 5, 60, the moving and monitoring image

and use of the opportunity to increase. So B enterprises rapidly reduced, while C enterprises dramatically decreased tend to 0, and at a lower level fluctuation, and A enterprises increased rapidly, eventually the number of A enterprises is significantly higher.

As can be seen from the corporate movement in the industrial clusters and monitor the simulation results comparison chart: After each of the parameters change, with the change of time, the number of A enterprises have increased, B enterprises first increased and then decreased, C enterprise shows the reduced tendency. But the increase or decrease in the quantity, scope, rate in different conditions will produce different results. The simulation results show that, H1 and H3 is not completely established, H2 fully established. That shows transfer threshold and the cluster network size affect the speed of knowledge transfer between enterprises, and has little effect on the amount of knowledge transfer. The knowledge gap on the inter-firm knowledge transfer has both positive and negative impact. Learning motivation and absorptive capability and network density on inter-firm knowledge transfer effect has a significant positive effect.

19.6 Conclusion

The above simulation results show that with the stronger learning motivation in the network enterprise in clusters, the better absorption ability, the enterprise knowledge transferring behavior will occur easier, and will be easy to keep going. The knowledge gap between enterprises enlarges a little, the affection of the enterprise knowledge transferring performs more obviously, so as to promote the improvement of the probability of knowledge transfer, choose to implement knowledge transfer strategy. System is high sensitivity for transfer threshold, and in order to improve the efficiency of knowledge transfer between enterprises, as the leader of the transferring-activity, which should be open mind in order to make knowledge mostly removed to the learning enterprise, and make common progress achieve. The expanding of network scale increased the opportunity for the enterprises contacting external knowledge, so as to influence knowledge transfer efficiency and speed. Therefore it has to keep certain scale for the network, to guarantee the efficiency of knowledge transfer. Along with the increase of network density, the network accessibility is stronger, so as to improve knowledge transfer behavior, ensure the knowledge value, and gain better knowledge transfer income, promote the enterprise take knowledge transfer strategy.

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Chapter 20
Optimal Subsidy for Abatement R&D in Different Organizations with Emissions Tax

Wei-jun Meng and Bin-yu He

Abstract By the three-stage game model for duopoly with emission tax that is exogenous, we examine how the government makes optimal subsidy policy in consideration of duopoly' organizations for abatement R&D. The results indicate: (1) with subsidy, social welfare in R&D cooperation is always higher than that in noncooperation; if the spillover of duopoly is relatively low the profit in cooperation is higher than that in noncooperation, if the spillover is relatively high the profit in cooperation is less; (2) with subsidy, if the spillover between duopoly is relatively low the duopoly prefer to choose cooperation in R&D, if the spillover is relatively high the duopoly prefer to choose non-cooperation in R&D. Different optimal subsidy policies shall be applied for R&D according to different organizations.

Keywords Environmental research joint venture · Environmental R&D subsidies · Emissions tax, spillover

20.1 Introduction

Emission tax is used to inspires firms invest R&D and cut emissions. And subsidy and encouragement of cooperation are also used to spur R&D in reducing emissions, subsidy for the innovation investment incentives and encouragement of cooperation for information sharing. In reality, R&D cooperation is encouraged

W. Meng (✉)
School of Management, Chongqing Jiaotong University, Chongqing 400074, People's Republic of China
e-mail: weijun_meng@126.com

B. He
Civil and Commercial law School, Southwest University of Political Science and Law, Chongqing 401120, People's Republic of China

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but not forced, depending on the benefit of firms obtained from that. And, when government provides subsidy firms can choose R&D cooperation or non-cooperation, even after the policy issued firms may change the forms of cooperation. Therefore, government must understand the firms' action in R&D under subsidy before policy is enacted; and firms will respond strategically. In the knowledge of the above, we will examine the relationship between subsidy and organization of R&D by a model based on imperfectly competitive oligopoly market with the emissions tax.

In industrial organization literatures, there are a lot of researches on organization of R&D and subsidy on R&D, but most of them focused on cost reduction. For example, d'Aspremont and Jacquemin (1988) and Kamien and Muller (1992) did initial game framework for R&D organization; Spence (1984), Qiu and Tao (1998), Romano (1989) and Sheng (2008) studied subsidy's effect on innovation in different sceneries. In a duopoly setting Huo Peijun (Peijun and Jixiang 2002) analyzed the optimal R&D subsidy policy for different R&D organization.

With the global environmental Problems getting worse, environmental policies, such as emission tax and emission standard, have been applied to deal with environmental externality with the aim of reducing emission, scholars gradually pay attention to emission abatement R&D. Petrakis and Poyago-Theotoky (2002) studied the optimal R&D subsidy to reduce cost and pollution. Ulph (1996) investigated the effect of environmental policy on R&D and compared the results between emission tax and emission standards. With endogenous emissions tax, Poyago-Theotoky (2007) compared investment level, profit and social welfare in the various forms of R&D organization with endogenous tax. But the above researches neglect the interplay between government and firms.

Based on the framework of d'Aspremont and Jacquemin (1988), a model, with exogenous emission tax, is designed to study the interacting between government subsidy decision and firms' R&D organization decision.

The paper includes five parts. Section 20.2 introduces the basic model. The optimal subsidy under emission abatement R&D competition is analyzed in Sect. 20.3. The optimal subsidy under emission abatement R&D cooperation is analyzed in Sect. 20.4. On the basis of Sects. 20.3 and 20.4 the comparisons of profit and social welfare in different organizations will be undertaken, the trade–off between subsidy decision and firms' R&D organization decision is also discussed. The conclusion is given in Sect. 20.6.

20.2 The Model

We focus on an industry, with an exogenous emissions tax t ($t > 0$), in which two firms offer homogeneous products which have the negative environmental externality. Firms can take abatement efforts in order to reduce their emissions and tax burden. Spillover happens between R&D activities of both. Firms will decide cooperation in emission abatement R&D or not according to the subsidy and industry spillover.

Two identical firms facing a linear inverse demand function. Let demand for the product be linear,

$$p = a - Q,$$

and $Q = q_i + q_j,\ i \neq j, i = 1, 2$; the size of the market parameter is a. The cost function for firm i includes independent production costs and R&D costs:

$$c_i(q_i, w_i) = cq_i + \frac{1}{2}\gamma w_i^2$$

c is a constant for unit costs of production, and a > c; the quadratic form addresses law of diminishing returns, where γ captures the relative effectiveness of R&D and w_i is the abatement effort of firm i. By method of Ulph (1996) (Peijun and Jixiang 2002) dealing with the relationship between emissions and quantity of production, a relevance to the total emission and overall output can be written as: $e_i = q_i - w_i - \beta w_j$, $i \neq j, i = 1, 2$; β is the spillover rate. Finally, the damage function is assumed to be quadratic in aggregate emissions $D(q_1, q_2, e_1, e_2) = (d/2)[\sum_{i=1}^{2} e_i]^2$: where d (d > 0) is the steepness of the damage function.

Based on the A-J models, we aim separately at resolving the optimal subsidy of cooperative R&D and competitive R&D in a three-stage game according to the three stages: in the first stage, the government chooses an optimal subsidy rate; second stage, firms choose R&D levels; firms decide quantity in the product market for competition in the third stage. Game Equilibrium will be obtained by backward induction.

20.3 Optimal Subsidy in Competition

In this section, the two firms compete in R&D. In the first stage the subsidy rate is set by the government, then firms choose the R&D level. Firms' cost function turns into the following form:

$$c_i(q_i, w_i) = cq_i + (1 - s)\gamma w_i^2/2, \quad -\infty \leq s < 1 \circ$$

Finally, firms compete in product market by choosing output. In this stage, firm i choose its output to maximize profit:

$$\max\left\{\pi_i = \left(a - q_i - q_j - c\right)q_i - (1 - s)\gamma w_i^2/2 - t\left(q_i - w_i - \beta w_j\right)\right\} \tag{20.1}$$

With first-order condition (FOC), we can obtain firm i's optimal output and profit:

$$q_i = (A - t)/3 \tag{20.2}$$

$$\pi_i = q_i^2 - (1-s)\gamma w_i^2/2 + t(w_i + \beta w_j) \tag{20.3}$$

Where $i \neq j, i = 1, 2$; A = a − c. From Eq. (20.2), we know that the optimal output is unrelated to the R&D level. With given emissions tax, let $q_i = q_N$, q_N is the optimal output under subsidy.

In the second stage the firm chooses the level of R&D to maximize profits, and by the Eq. (20.3), we can get the optimum R&D level on subsidy rate by FOC. We get,

$$w_i = w_j = t/[\gamma(1-s)] \tag{20.4}$$

In stage 1, government sets the subsidy rate that maximizes social welfare. Welfare function contains the producer and consumer's surplus and the environmental damage. The function is as following (Sheng 2008; Petrakis and Poyago-Theotoky 2002):

$$F = \int_0^{2qN} (a - c - x)dx - \frac{1}{2}\gamma \sum w_i^2 - \frac{1}{2}d\Big[2q_N - (1+\beta)\sum w_i\Big]^2$$

Above equation can be rewritten as follows:

$$F = 2Aq_N - 2q_N^2 - \gamma w_i^2 - 2d[q_N - (1+\beta)w_i]^2 \tag{20.5}$$

Maximizing Eq. (20.5) for the optimal subsidy rate, we can solve its first order condition, as following:

$$s_N^* = 1 - \frac{3t[\gamma + 2d(1+\beta)^2]}{2\gamma d(A-t)(1+\beta)} \tag{20.6}$$

From Eq. (20.6), if t = 0, then $s_N^* = 1$, which means firms have no incentive to undertake abatement activities without emissions tax, and subsidy means government take all the R&D costs. Since $t > 0, \partial s_N^*/\partial t < 0$, as the tax rate increases, the subsidy decreases. It is obvious that if strict tax policy is applied government may not subsidize R&D, and emission tax is very high, even R&D may be restricted to reduce production and consumption of such products and thereby reduce damage to environment. Therefore, there exists a critical value t_N^*, by setting $s_N^* = 0$, we obtain:

$$t_N^* = [2\gamma dA(1+\beta)]/[3\gamma + 6d(1+\beta)^2 + 2\gamma d(1+\beta)]$$

When $t \geq t_N^*$ and then $s_N^* \leq 0$, government does not provide subsidy or began to enact tax on emission R&D. However, in the case of cost reduction, there is no negative subsidy for R&D (Sheng 2008), which indicates the difference between emission abatement and cost reduction. Here we still assume that subsidy is positive value in this study.

By the solved optimum subsidy rate [in (20.6)], we can get R&D, profit and social welfare in equilibrium as followings:

$$w_N = \frac{2d(A-t)(1+\beta)}{3[\gamma + 2d(1+\beta)^2]} \tag{20.7}$$

$$\pi_N = q_N^2 - (1-s)\gamma w_N^2/2 + tw_N(1+\beta) \tag{20.8}$$

$$F_N = 2Aq_N - 2q_N^2 - \gamma w_N^2 - 2d[q_N - (1+\beta)w_N]^2 \tag{20.9}$$

20.4 Optimal Subsidy in Cooperation

In this section, firms will cooperate in R&D stage. They share information and coordinate in R&D investment to make the total profit of the two sides maximized. In the third stage, the solution process for output is just as the R&D competition. The optimal production and profit are given by (20.10) and (20.11),

$$q_i = q_c = (A-t)/3 \tag{20.10}$$

$$\Sigma\pi_i = \Sigma q_i^2 - (1-s)\gamma\left(\Sigma w_i^2\right)/2 + 2t(\Sigma w_i) \tag{20.11}$$

In the second stage firms choose R&D levels to maximize profits, by maximizing Eq. (20.11) to get FOC, the optimal R&D levels are

$$w_i = w_j = 2t/[(1-s)\gamma] \tag{20.12}$$

In the first stage, the regulator chooses the R&D subsidy rate to maximize total welfare. From (20.5), we can get the following social welfare function:

$$F = 2Aq_c - 2q_c^2 - \gamma w_i^2 - 2d[q_c - 2w_i]^2 \tag{20.13}$$

by Eq. (20.12) into (20.13) we can solve an optimal subsidy rate.

$$s_c^* = 1 - \frac{3t[\gamma + 8d]}{2\gamma d(A-t)} \tag{20.14}$$

Given the optimal subsidy, we obtain the equilibrium R&D level, profit and social welfare:

$$w_c = \frac{4d(A-t)}{3(\gamma + 8d)} \tag{20.15}$$

$$\pi_c = q_c^2 - (1-s_c^*)\gamma w_c^2/2 + 2tw_c \tag{20.16}$$

$$F_c = 2Aq_c - 2q_c^2 - \gamma w_c^2 - 2d[q_c - 2w_c]^2 \tag{20.17}$$

20.5 Comparison and Discussion

If R&D subsidy is given, how firms will response, R&D cooperation or competition? So it is necessary to compare the profit and the social welfare in the case of cooperation and non-cooperation, we make the further analysis according to the comparisons.

20.5.1 Profit Comparison

Taking the outputs q_N and the R&D level w into (20.8), we can write the equilibrium function as:

$$\pi_N = q_N^2 + tdq_N[2(1+\beta)^2 - (1+\beta)]/[\gamma + 2d(1+\beta)^2] \tag{20.18}$$

by (20.14), (20.15) and (20.16) we obtain:

$$\pi_c = q_c^2 + 4tdq_c/(\gamma + 8d) \tag{20.19}$$

If $q_c = q_N$, when $\beta = 0$, then $\pi_c - \pi_N > 0$; in the case $\beta = 1$, $\pi_c - \pi_N < 0$;

With (20.18), it is easy to know $\partial\pi_N/\partial\beta > 0$. Therefore there is a crucial value β_π^*, which leads to $\pi_c - \pi_N > 0$ as $\beta < \beta_\pi^*$ and vice versa. Let $\pi_c - \pi_N = 0$, the critical value can be solved:

$$\beta_\pi^* = \frac{\sqrt{(\gamma + 8d)^2 + 32\gamma(\gamma + 4d)} - (3\gamma + 8d)}{4(\gamma + 4d)} \tag{20.20}$$

To any $\gamma, d > 0$, $\beta_\pi^* \in (0, 1)$.

Conclusion 1: With subsidy, if the spillover between firms is less than the crucial value the profit in cooperation is higher than that in non-cooperation; if the spillover is larger the profit in cooperation is less.

From above analysis, it indicates that information sharing and coordination of R&D investments do not always help to improve profits for private.

20.5.2 Welfare Comparison

By Eqs. (20.7) and (20.9) we get social welfare in non-cooperation R&D with subsidy policy:

$$F_N = 2Aq_N - 2q_N^2(1 + \gamma d)/[\gamma + 2d(1+\beta)^2] \tag{20.21}$$

By (20.15) and (20.17), social welfare in R&D cooperation with subsidy can be written as follows:

$$F_c = 2Aq_c - 2q_c^2(1 + \gamma d)/(\gamma + 8d) \tag{20.22}$$

Let $q_c = q_N$, if $\beta = 0$, $F_c > F_N$; if $\beta = 1$, $F_c = F_N$; and since $\partial F_N/\partial \beta > 0$, for $\beta \in [0, 1]$, then $F_c \geq F_N$.

From the above it can be learned that the social optimum R&D level is achieved effectively by double regulation of information sharing and subsidy.

Conclusion 2: with subsidy, social welfare in R&D cooperation is not lower than that in R & D competition.

By above analysis, obviously the government and business have conflict of interest in R&D organization, further discussion will be done in the next section.

20.5.3 Game Equilibrium

By comparison of the social welfare and profit in cooperation and those in non-cooperation, it is indicated that the social welfare in cooperation is always higher than (or equal to) that in non-cooperation. For firms' interest, information sharing and R&D investment coordinating do not always contribute to promote profit. So on the issue of R&D cooperation, there exists conflict between government and firms. Before making decision of subsidy rate government must take the firms' profits into account, while firms also have to consider the impact of governmental subsidy in deciding the level of R&D in advance. Thus, without knowledge of organization chosen by firms after policy released, unreasonable subsidy can't contribute to reach optimal social welfare in reality. So how firms and government decide dynamically?

In Sects. 20.2, 20.3 and this part, we learn that the decision of R&D organization depends on spillovers, and that the optimal subsidy corresponding to the given spillover is sole. Obviously, it is simple to make subsidy policy if government knows the spillover rate. When $\beta < \beta_\pi^*$, if firms realize subsidy may be provided, they will take cooperative R&D organization to pursue more profits, and the government realizes that subsidy in cooperation will generate more social welfare. So s_c^* is government's optimal strategy. When $\beta \geq \beta_\pi^*$, firms take non-cooperation organization for more profit, and the government only takes s_N^* to achieve the maximal social welfare.

Conclusion 3: when the industry spillover is less than critical value, the optimal subsidy rate to government is s_c^* and firms take cooperation in R&D; when the spillover is larger, s_N^* is the government optimal policy, firms take non-cooperation in R&D.

The implication is that subsidy and encouragement of cooperation are effective in promoting emission abatement R&D and improving social welfare. So subsidy policy shall be supported with measures to promote cooperative R&D joins and improve spillovers, such as strengthening the exchange of R&D in environmental protection, and spreading through various means of advanced environmental technology and so on.

20.6 Conclusion

By the three-stage game model for the duopoly with spillovers that are exogenous, we analyze how the government makes optimal subsidy policy in consideration of firms' organizations of abatement R&D. Research results indicate that under the conditions of the subsidy the change of spillover affects inter-firm cooperative behaviors, the mix of subsidy and encouragement of cooperation is an effective way of improving public welfare. So for the government, promoting the spillover by encouraging and strengthening the cooperation and spreading new technologies will help to improve social welfare.

The work above enriches research in the area of application of technology policies (subsidy and encouragement of cooperation) in emissions reduction, which is maybe a practical guide to policy on environmental R&D. But the study is based on the symmetry of firms. But in reality firms may be asymmetry, subsidy may be asymmetry, and subsidy may be put on firms in sequence rather than same time. Therefore future study shall be focused in asymmetry.

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Chapter 21
Performance of the Product Innovation Team and Organizational Structure Characteristics from the Perspective of Cross-Level Research

Xu-gao Qi, Er-shi Qi and Liang Liu

Abstract Today, the product innovation team is used widely, but the performance is not satisfying. This study makes the four dimensions of enterprise organizational structure characteristics as explanatory variables, the team level of knowledge integration capabilities as mediated variable, builds a cross-level conceptual model about performance of the product innovation team, and uses hierarchical linear model to analyze cross-level survey data on 326 product innovation team of 83 manufacturing enterprises. We find that every dimension of organizational structure characteristics has cross-level effect on performance of the product innovation team; knowledge integration capabilities of team level have part mediated effect between centralized or flexible organizational structure and performance of the product innovation team. In the flat degree and product innovation team performance has full mediated effect, the mediated effect between the degree of standardization and product innovation team performance is not significant.

Keywords Hierarchical linear model · Knowledge integration · Organizational structure · Product innovation team

21.1 Introduction

In the era of knowledge economy, facing the global competition, more and more enterprises adopted product innovation team to speed up the integration of internal and external knowledge resources, promoting product innovation process. How to promote the product innovation team performance had become an important issue

X. Qi (✉) · E. Qi · L. Liu
College of Management and Economics, Tianjin University, Tianjin, China
e-mail: td_leo@163.com

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in theory and practice. Woodman believed that the outcome variables relevant innovation needs to consider the interaction from three levels: individual, group and organization (Woodman et al. 1993). Product innovation team as a typical knowledge-based team embedded in organization inside was the ideal knowledge integration unit, and the organizational structure of enterprises as the carrier of knowledge, different organization structure would promote or restrict knowledge integration, and then affected performance of the product innovation team. Although a large number of scholars had already studied the team performance from the team structure, team learning, team leader aspects (Cohen and Bailey 1997; West 2002), yet most of them were from the team level, the cross level study was still scarce.

Therefore, this research would use the cross level analysis method, studies hierarchical relationship between the organizational structure characteristics and team level knowledge integration capability, performance of the product innovation team, with a view to provide the theory basis and the practical instruction through organization innovation to speed up the integration of knowledge, and enhance product innovation team performance.

21.2 Theoretical Basis and Hypothesis

Organization structure was the knowledge carrier, and organization structure characteristics affected knowledge interaction and sharing of the organization teams and team members. Centralization strictly followed the unified command chain, and knowledge integration of the team members was limited by the fixed longitudinal channels of communication, while multidimensional, horizontal and longitudinal interactive collaboration would effectively improve those capabilities. In addition, centralization of the organization made organization teams or team members unable to get the comprehensive information and knowledge, so they had difficulty to understand knowledge structure and specific knowledge from the whole. But only from the overall understanding and recognition, we would grasp the key and essentials for effective integration of knowledge (Cabrera and Cabrera 2002). Standardization emphasized the compliance of the established rules and work process, created control and lack of elastic environment, and resulted in the response to environmental changes of the organizational members according to established work mode to make reaction. Organizational environment rigid would influence organizational team on a variety of innovative knowledge, and many problems and solutions couldn't be widely discussed and improved, resulting in low efficiency of the knowledge sharing mechanism. Only through effective knowledge sharing mechanism, establishing reasonable relationship of the extant knowledge, the individual component knowledge would rise for the organization structure knowledge, and pushed complex explicit knowledge or tacit knowledge to integration new knowledge (Hill and Levenhagen 1995). Thus, this study proposed the following hypothesis:

H1a: Organizational structure centralization had significant negative impact on the knowledge integration capability of the team level

H1b: Organizational structure standardization had significant negative impact on knowledge integration capability of the team level.

Flat organization was of multidimensional information and knowledge exchange channels and members of the team might carry out extensive horizontal or vertical knowledge exchange and interaction, which would contribute to individual tacit knowledge into explicit knowledge, strengthened specific capability, raised cross level from the individual level knowledge to team level knowledge. Meanwhile, flat would separate the organizational decision-making power to the mastery of knowledge of the team, which was good to recognize the specific value of knowledge and the integration direction. Flexible organizational emphasized the environment and market demand changes in a timely response, often used to break the sector boundaries, authorization, team cooperation etc., enhanced organizational flexibility and adaptability. It was not only conducive to have more opportunities to contact with different organizational units or members, promoted the knowledge interaction and integration, and was favorable to establish the strong coupling relationship, which contributed to the experience, know-how and ways of thinking of tacit knowledge into explicit knowledge (Mohamed et al. 2004). Thus, this study proposed the following hypothesis:

H1c: Organizational structure flat had significant positive impact on knowledge integration capability of the team level

H1d: Organizational structure flexibility had significant positive impact on knowledge integration capability the team level.

Product innovation was a knowledge integration and creative process. Product innovation team as the undertaker of the innovation, belonged to typical knowledge cooperation unit, was the "Ba" of the internal knowledge creation (Nonaka and Konno 2005). Knowledge integration for product innovation could not only increase orderliness, systematic and fusion, and could make implicit, non structured knowledge explicit, resulting in shortening the cycle of new product innovation and enhancing product quality. Boer (De Boer et al. 1999) believed that knowledge itself did not generate performance, integrated knowledge would guide the organization to combine product and market, got the fast and effective product innovation, and finally obtained the innovation performance. Sivadas and Dwyer (2000) also showed that lacking of knowledge integration capability was the essential problem that enterprise didn't realize product innovation target. In addition, in the excellent team of knowledge integration capability, through the system of education and training, team members could integrate knowledge from as little as possible interaction, it could not only shorten the product innovation process, and reduced risk and cost of the product innovation. Thus, this study proposed the following research hypothesis.

H2: Knowledge integration capability had significant positive effect on product innovation team performance.

Based on the above, this study considered organization with high degree of centralization and standardized inhibited product innovation team performance promotion, and flattened, high degree of flexible organization structure promoted product innovation team performance. That was because that in the background of knowledge economy, flat, flexible organization structure was more conducive to knowledge restructuring, transformation and knowledge integration capability could achieve higher innovation performance. Therefore, according to the relevant research, this paper attempted to research the cross level effect of the organizational structure characteristics on the performance of product innovation team. Therefore, this research proposed the following hypothesis.

H3: Knowledge integration capability had a mediated effect on the organization structure and product innovation team performance.

21.3 Research Design

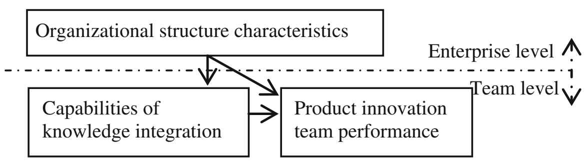
21.3.1 Research Methods

This study used hierarchical linear model (HLM) and in turn test regression coefficient method to do cross level analysis, and inspected cross level mediated effect between capabilities of knowledge integration in the organizational structure and product innovation team performance. Among them, the knowledge integration capability, product innovation team performance was for the team level variable, the characteristic of organizational structure was the enterprise level variable (Fig. 21.1).

21.3.2 Variable Measured

The questionnaire of this paper was for business leaders and team leaders. Business leader questionnaire included basic information, organizational structure characteristics, and team leader questionnaire contained capabilities of knowledge

Fig. 21.1 Cross level concept model of affecting product innovation team performance



integration and product innovation team performance variables. Questionnaire used scale that previous literatures abroad had used as far as possible, according to the appropriateness and clarity of the questionnaire items did the enterprise pre test, and modified with the feedback of results and related scholars views. Questionnaire items used a five point rating scale measurement.

In Miller and Droge (1986) research foundation, organizational structure scale was divided into centralization, standardization, flat and flexible four dimensions, and in the Li's (Li and Si 2009) scale revision to the common questions, there were totally twelve questions.

The scale value of KMO was 0.847, factor analysis item had a single dimension characteristic, and the load was between 0.816 and 0.881. Knowledge integration ability scale integrated Kogut's (Kogut and Zander 1992) point of view, in the Taiwan scholar He's (2003) scale revision to the common questions, there were five questions, table KMO value was 0.724, factor analysis item had a single dimension of features, and the load in 0.728–0.846. Product innovation team performance scale modified from Lovelace (Lovelace et al. 2001), Faraj (Faraj and Sproull 2000), a total of six questions, table KMO value was 0.782, factor analysis item had a single dimension characteristic, and the load in 0.642–0.803. Table 21.1 showed the scale of Cronbach's α coefficient was in 0.778–0.872, which showed that the scale was reliable. From the confirmatory factor analysis, the model was fitting better (Table 21.2).

21.3.3 Research Sample

The survey of this study was from 2011 June to October, respectively to Hebei, Tianjin, Shandong, Jiangsu, Yunnan, Inner Mongolia, Guangdong, Sichuan, Heilongjiang and other 9 provinces and 229 manufacturing enterprises with product

Table 21.1 Cronbach's α coefficient of each scale

Variable	Item	Cronbach's α
Degree of concentration (DCE)	3	0.853
Degree of standardization (DST)	3	0.790
Degree of flat (DFL)	3	0.834
Degree of flexibility (DFE)	3	0.778
Knowledge integration capability (KIC)	5	0.864
Product innovation team performance (PIT)	6	0.872

Table 21.2 Confirmatory factor analysis results

	x^2/df	AGFI	PGFI	NFI	RFI	CFI	RMSEA
Product innovation team performance	2.87	0.85	0.72	0.94	0.90	0.97	0.032
Knowledge integration capability	2.06	0.92	0.81	0.91	0.95	0.98	0.086
Organization structure characteristics	2.76	0.89	0.79	0.97	0.92	0.93	0.057

innovation capacity to issue questionnaires. After deleting invalid questionnaires, we recovered the effectively questionnaires of enterprise level 83, effective rate of recovery was 36.7 %, while 326 effective questionnaires of team level, the effective return rate was 35.9 %.

83 effective samples enterprises, from the distribution of region, area of the east part 50.6 %, central region accounted for 28.9 %, west accounted for 20.5 %; from company property, the state owned and collective enterprises accounted for 31.3 %, private enterprises 45.8 %, joint ventures and foreign-funded enterprises 22.9 %; from the enterprise scale, there was 3 enterprises whose number of employees under 100 people, 16 enterprises under 500, 21 enterprises under 1,000, 26 enterprises under 2,000, 17 enterprises more than 2,000; industry classification, manufacturing accounted for 27 %, electronic communications 33 %, food chemical 9 %, biological medicine 19 %, software development 12 %; in the sample of 326 teams, teams with 3–5 persons accounted for 15.6 %, 5–20 accounted for 76.2 %, more than 20 people 8.2 %. The team established in the shortest time was 2 months, the longest for 43 months, and founded more than 6 months accounted for 73.9 %.

21.4 Result

This study used mean variables to represent variable score. Mean, standard deviation and correlation coefficient from enterprise level and team level were as shown in Table 21.3. Because it was a cross-level effect, besides the product innovation performance as the outcome variable, knowledge integration capability as mediated variable would also be served as outcome variable. Therefore, according to the steps of the multilevel mediated effect analysis, we got the interclass correlation coefficient (ICC) of the product innovation team performance and knowledge integration capability to determine the applicability of cross level analysis. Using HLM6 to do the zero model (random effects ANOVA model) test on the product innovation team performance variable and knowledge integration capability variable, we got the ICC were 0.15, 0.21 (more than 0.06 Fang et al. 2010) which showed differences among different enterprises had considerable part of the variance in two variables and this paper was suitable for the use of hierarchical linear model analysis.

Table 21.3 Descriptive statistics analysis of two levels

	N	Mean	SD	1	2	3	4
DCE	83	3.34	0.73	1			
DST	83	3.58	0.82	0.317**	1		
DFL	83	2.87	0.87	−0.402**	−0.151	1	
DFE	83	2.91	0.93	−0.357**	−0.234**	0.658**	1
KIC	326	2.82	0.82	1			
PIT	326	2.79	0.79	0.602**	1		

$P < 0.01$, $^{*}P < 0.05$

Table 21.4 HLM6 estimation results

Model	Fixed effect		Random effect	
	γ		Intercept variance	Slope variance
Intercept-as-outcome models				
M1a DCE → PIT	γ_{01}^{1}	−0.152**	0.254**	–
M1b DST → PIT	γ_{02}^{1}	−0.107	0.169*	–
M1c DFL → PIT	γ_{03}^{1}	0.149**	0.268**	–
M1d DFE → PIT	γ_{04}^{1}	0.174**	0.197*	–
M2a DCE → KIC	γ_{01}^{2}	−0.116**	0.176*	–
M2b DST → KIC	γ_{02}^{2}	−0.083*	0.272**	–
M2c DFL → KIC	γ_{03}^{2}	0.163**	0.143*	–
M2d DFE → KIC	γ_{04}^{2}	0.187**	0.106*	–
Random ANCOVA				
M3 KIC → PIT	γ_{10}	0.487**	0.289**	–
Random coefficient models				
M4 KIC → PIT	γ_{10}	0.469**	0.294**	0.103

**P < 0.01,*P < 0.05

According to the steps of hierarchical linear model meditational analysis, we firstly inspected whether the product innovation team performance and knowledge integration capability variable could be explained effectively by the organizational structure characteristics in enterprise level and we built the intercept-as-outcome models (M1a-M2d).

From the results of Table 21.4, centralization on product innovation team performance had a significant negative effect($\gamma = -0.152$, $p < 0.01$), the knowledge integration capability in team level also had a significant negative effect($\gamma = -0.116$, $p < 0.01$), hypothesis H1a was supported; standardization on team level of knowledge integration capability had an obvious negative impact ($\gamma = -0.083$, $p < 0.05$), hypothesis H1b was supported, on product innovation team performance had a negatively effect, but the effect was not distinct; flat on product innovation team performance had significant positive correlation ($\gamma = 0.149$, $p < 0.01$), on knowledge integration capability also produced significant positive affect ($\gamma = 0.163$, $p < 0.01$), hypothesis H1c was supported; flexibility on product innovation team performance had positive correlation ($\gamma = 0.174$, $p < 0.01$), on knowledge integration capability also produced positive effect ($\gamma = 0.187$, $p < 0.01$), hypothesis H1d was supported. In addition, intercept variance of the models were significantly, which illustrated there were still other enterprise level variables on product innovation team performance and knowledge integration capability.

Secondly, we inspected whether results variable could be effectively explained by intermediary variable. The HLM model did not incorporate the enterprise level explanatory variables, when the slope coefficient setting for fixed effect, the model

Table 21.5 The multilevel mediated effect

Model	Fixed effect		Random effect
	γ	γ_{10}	Intercept variance
M5a DCE KIC → PIT	γ_{01}^{3} −0.144**	0.387**	0.219**
M5c DFL KIC → PIT	γ_{03}^{3} 0.136	0.462	0.203**
M5d DFE KIC → PIT	γ_{04}^{3} 0.169**	0.392**	0.181**

**P < 0.01, *P < 0.05

was with random effects analysis of covariance model(M3), when the slope coefficient setting for random effect, the model was random coefficients model (M4). From the results in Table 21.4, γ of random effects analysis of covariance model reached significant level ($\gamma = 0.487$, $p < 0.01$), namely the capabilities of knowledge integration for product innovation team performance had a significant positive effect; the results of random coefficient model and covariance model were similar ($\gamma = 0.469$, $p < 0.01$), and the slope of variance was not significant, also meant that the intermediary variable for product innovation team performance had a significant positive correlation. Therefore, H2 gained supported.

The third step of HLM mediated effect model was to put explanatory variables and intervening variables into the hierarchical linear model, testing the extent of interpretation to distinguish the mediated effect. Standardization of product innovation team performance negative impact was not significant, according to Baron and Kenny (1986) intermediary effect judging method, knowledge integration capability did not have intermediary effect between standardization and product innovation team performance. Therefore, we put the other three dimensions of the organizational structure and knowledge integration capability variables simultaneously into the hierarchical linear model, testing the extent of interpretation. According to the data in Table 21.5, referring to Baron and Kenny (1986) intermediary effect judging method, M5a γ and γ_{10} coefficients were significant, and compared with the M1a have some degree of decline, which meant that knowledge integration capability in centralization and product innovation team performance had partial mediated effect; M5c γ and γ_{10} coefficients were not significant, illustrated the capabilities of knowledge integration in the flat and product innovation team performance had a full mediation effect; M5d γ and γ_{10} coefficients were significant, illustrated the capabilities of knowledge integration in flexibility and product innovation team performance had partial mediated effect. To sum up, hypothesis H3 partial gained supported.

21.5 Conclusion and Discussion

This study made the four dimensions of enterprise organizational structure characteristics as explanatory variables, the team level of knowledge integration capabilities as mediated variables, built a product innovation team performance cross-level conceptual model, and used hierarchical linear model to analyze cross-level survey data on 326 product innovation team of 83 manufacturing enterprises. We found that each dimension of the cross-level organizational structure characteristics impacted the performance of the product innovation team; knowledge integration capabilities of team level had part mediated effect between centralized or flexible organizational structure and the performance of the product innovation team. In the flat degree and product innovation team performance had full mediated effect, the mediated effect between the degree of standardization and product innovation team performance was not significant. The conclusion showed that although to a certain extent product innovation team reduced the bad effect to the product innovation activities such as mechanism rigid, much enterprise organization structure and slow reaction, yet product innovation team was embedded in the internal organization, the organizational structure would influence product innovation team performance through intermediary variables like knowledge integration capability, so that product innovation team performance had significant difference among enterprises.

Conclusions had certain enlightenment on Chinese manufacturing enterprise product innovation team management practice: Firstly, our manufacturing enterprises should pay attention to create environments contribute to product innovation team performance from the organizational structure. Chinese manufacturing enterprises mostly followed the traditional hierarchical organization structure; different organization structure on product innovation team performance cross levels influence should not be ignored. The research results indicated that the established with decentralization, flat and flexible helped knowledge integration of the team level, and would improve the team performance. Secondly, Chinese manufacturing enterprises in the use of product innovation team to accelerate knowledge integration, not only attached importance to the team founded, should pay more attention to internal team knowledge integration capability. Enhancing team knowledge integration capability would play cooperation effect, had continuing ability to innovate, and achieved good team performance.

Although this study had obtained some new findings and to some extent promoted the product innovation team performance cross level analysis, but there were also some limitations. The first was the study sample limitations, because this study mainly used manufacturing enterprise product innovation team as samples, and the questionnaire was divided into enterprise level and team level, so that the data collection became more difficult, resulting that less enterprise involved in the investigation, though meeting the analysis requirement, yet more enterprise level number was better; secondly, although this research showed that the organizational structure on product innovation team had cross level effect, but studies had been found there were other enterprise level factors influencing product innovation team performance. Therefore, if we could add the other enterprise level variables, we would make the results more meaningful.

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Chapter 22
Research on Enterprises' Innovation Performance in University-Industry-Government Networks Based on Absorptive Capacity

Yang Wang, Zhao Duan and Ji Xiong

Abstract The cooperation of University-Industry-Government is the core part of the national innovation system, its causes and core actually are knowledge resources' obtaining and absorption in the final analysis. Enterprise as the main body in University-Industry-Government cooperation, its innovation achievements play an important role in its development. This paper stood in the enterprise's microcosmic view, based on dynamic absorption ability theory, saw industrial enterprises in Hubei province as the research objects, explored how the factors of combination's network level and enterprise itself level positive influence the enterprises' innovation performance through the enterprise absorptive ability this bridge.

Keywords Absorptive capacity · Influence factors · Innovation performance · University-industry-government networks

22.1 Introduction

During the process of our country implementing independent innovation strategy and promoting technological innovation system that "Enterprises as the mainstay, market-oriented, make the combination of production, teaching and research", in

Y. Wang (✉) · Z. Duan · J. Xiong
Department of Information and Management, Central China Normal University, Wuhan, China
e-mail: cocotata@126.com

Z. Duan
e-mail: victorduan@tom.com

J. Xiong
e-mail: xiongji1987920@sina.com

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addition to enterprises, universities, scientific research institutions three individuals' cooperation and innovation, the governments' macro regulation and coordinate work also appear especially important, more and more scholars made the "Triple Helix" model that includes government into the important measures which promoting technological innovation in our country. We can through the collaborative innovation of university-industry-government to realize the optimized combination of each technology innovation element and improve the utilization rate of innovation resources and the final technology innovation performance. The enterprise which is the main subject in the combination of university-industry-government only has a high level of absorption ability it can learn and absorb knowledge and technology from outside efficiently. This paper focused on absorptive capacity perspective and through macro political cooperation network structure and micro enterprise individual capacity these two angle explore the factors that influence enterprise's innovation and through empirical analysis to analysis the weight of each factors. Finally we obtained some countermeasures and suggestions to help promote enterprise's innovation and increase market competitive power.

22.2 Literature Review

In the cooperation of university-industry-government, the governments, enterprises, universities and research institutions cooperate with each other in order to complementary resources. Under the protection of each policies the enterprises absorb, transform and apply the knowledge and technology from university and scientific institution to the process of product or service improvement. Etzkowitz and Leydesdorff (2000) use "Triple Helix" model analysis the interaction among industry, universities and governments. Cohen and Levinthal (1990) thought the enterprise use the knowledge that came from their competitors, governments, universities and laboratories to create innovative new knowledge.

22.2.1 Absorptive Ability

It's believed that the absorptive capacity is the ability that enterprises obtain, transfer and use external knowledge for commercial application. From the bilateral relations of the "Student Enterprise" and "Teacher Enterprise" we can define the absorptive capacity. Zahra and George (2002) defined absorptive capacity as a set of organizational rules, the enterprises through these rules to achieve the acquisition, digestion, transformation and utilization of the external knowledge. Then Todorova and Durisin amended the Zahra and George's model in the restatement of the model of Cohen and Levinthal (Todorova 2007). This article refers to Todorova and Durisin's model divided absorptive capacity into identification ability, obtain ability, digestive ability (or transform ability) and application ability.

22.2.2 The Cooperation of University-Industry-Government

The cooperation of university-industry-government mainly refers to technological innovative mechanism that the governments, enterprises, universities and scientific research institutions make the market as the basis, through resources complementing each other and promoting common development so as to achieve win–win goal, thus achieving an effective combination of various productive factors that technological innovation required. Inter-regional knowledge transfer ration, the most interesting is the cross-domain knowledge transfer, especially from the scientific field to the economic field (Corsten 1987).

22.3 Analysis of Factors that Influence Innovative Performance

22.3.1 The Factors at Cooperation Network Level

Enterprises in the cooperation network of university -industry-government, the network's formation, structure, governance and evolution will affect the innovation performance and competitive posture (Pittaway et al. 2004). We got four factors:

- The vision and goals of cooperation

Development vision on behalf of the enterprise does strategic thinking and planning according to network evolution. The goals of cooperation reflects the gap between their own stock of knowledge and the actual needs, thereby increasing the intention of learning, thus improving the efficiency of learning and the quality of absorption of new knowledge.

- Government support

The government does the macroeconomic regulating and controlling, it is the unique one which is able to coordinate the control for the relationship between different actors stunning.

- Coalition

The choice of union form expressed the establish links between companies, universities, research institutions and governments, developing partner's potential to create the desire that go beyond the value of their own ability.

- Trust, exchange and communication

Exchange is essential between any two organizations. Among universities, research institutions and enterprises there is only the mutual understanding, trust can maximize complete the transformation of scientific research from the academic to the industry. Mohr and Nevin thought the process of exchange and communication is the opportunity for us to enhance loyalty between organizations (Mohr and Sengupta 2002).

22.3.2 The Individual Factors

Gambardella studies suggest that raising the ability of individual enterprises, especially the improvement of knowledge absorptive capacity can help companies to more effectively enhance the capacity of technical knowledge from external sources (Gambardella 1992). Among constituent elements of enterprises' innovation ability, the absorptive capacity is a key part.

- Enterprise Strategy

Enterprise through overall strategy to express the direction of efforts. It through the allocation of resources to affect the enterprises identify, absorb and apply knowledge from external organizations, and ultimately impact business goals.

- The stock of knowledge

The corporate stock of knowledge includes enterprises' basic skills, technological knowledge and the number of patents, hardware, and market knowledge. The more lucrative corporate stock of knowledge, the easier it can identify new external knowledge and apply them to create their own higher value.

- R & D activities

The ability for enterprises to use new external knowledge is a by-product of the so-called R & D activities; these activities not only promote the development and progress of the innovation activities but also add to the store of knowledge.

- The organization structure

The organizational structure shows the platform of knowledge sharing, exchanging and transferring between members, played a catalytic role in the internal knowledge transfer ration and absorption. Teece et al. (1997) thought the organization structure is an important factor that affects the company's dynamic capabilities.

22.4 Hypothetical

For businesses, knowledge transfer between internal staff departments and among external network organizations all depend on the ability of enterprises' absorbing. We will consider absorptive capacity as an entry point to study the structural factors of the macro network and micro-enterprises individual factors. We can through identification ability, obtain ability, digestive ability (or transform ability) and application ability to explore the impact on innovation performance. The specific logical relationship as shown in Fig. 22.1.

22.4.1 Business Innovation Performance Analysis

Innovation performance is the effectiveness of enterprises' innovative activities. This article divided the innovation performance into the fruitful innovative

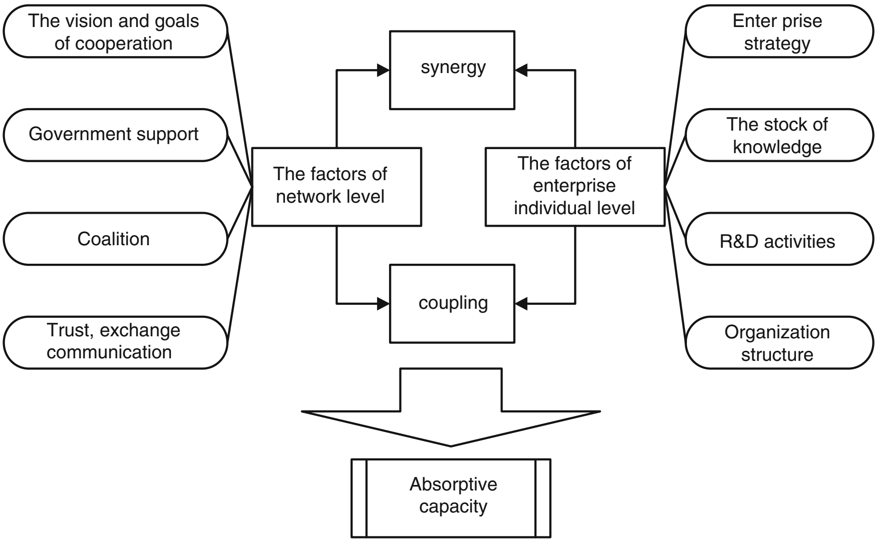

Fig. 22.1 A model of logical relationship for influences

performance and growth innovative performance two types of indicators in political and research cooperation (Fig. 22.2).

22.4.2 Hypothesis

- The influences that the network capacity of the cooperation of Government Industry Education and Academy has on enterprises' absorb capacity

For the cooperation network of Government Industry Education and Academy, the network structure and links between nodes at different levels promote obtaining information from the external network system resources and identifying.

H1 The corporate network capacity has a significant positive impact on absorptive capacity

- The influences Enterprises' individual ability has on the absorptive capacity

In the political and research network, enterprises with strong individual ability not only has the full capacity factors, and when the enterprises identify digest and absorb information from external resources they can draw useful information under the direction of market development and convert it more efficiently.

H2 The enterprise individual capacity has a significant positive impact on the absorptive capacity

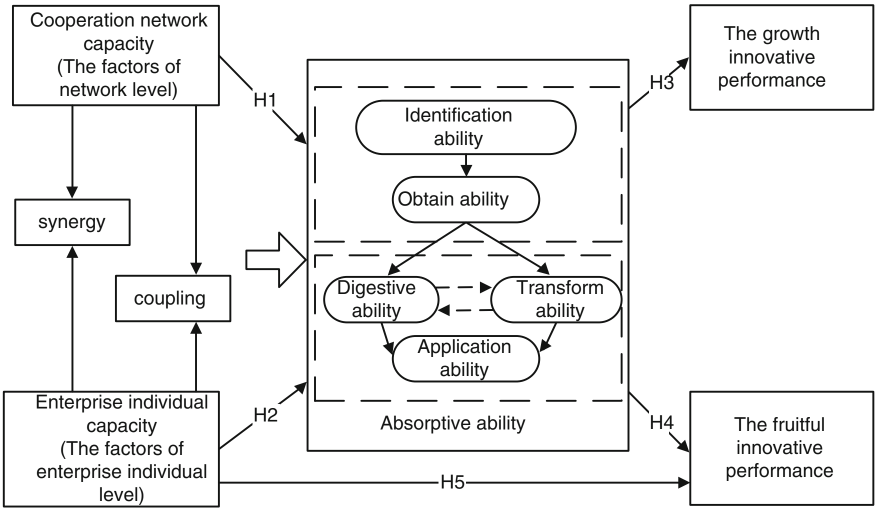

Fig. 22.2 A model of hypothesis' logical relationship

- The absorptive capacity's influences on the innovation performance of enterprise growth

Nooteboom et al. thought, the size of the innovation capability has a positive correlation with organizational absorptive capacity. The stronger the absorptive capacity the organization has, the greater the innovation capacity the enterprises in alliance has (Nooteboom et al. 2007).

H3 The absorptive capacity has a significant positive impact on the new innovation performance of business growth

- The influences the absorptive capacity has on business' innovation performance on results

The enterprises which have better absorptive capacity of can efficiently identify the results from universities and research institutions and applied them to the needs of their own economic development.

H4 The absorptive capacity has a significant positive impact on innovation performance in business results

- The influences enterprises individual ability has on the innovation performance of research results

Laursen and Salter proposed that the development strategy of the business can provide a mechanism for enterprises to seek knowledge from external organizations. The mechanism improves the efficiency and effectiveness that the enterprise's obtaining knowledge from the outside world (Laursen and Salter 2004).

H5 The individual firm capabilities have a significant positive impact on innovation performance of results

22.5 The Test of Hypothesis

22.5.1 Data and Sample

The research object of this paper are above-scale industrial enterprises in the Hubei Province, including communications, electronics, biotechnology, chemical, food and other industries. Survey using random sampling to select the sample of enterprises in Wuhan, Xiangyang, Yichang those are representative cities in Hubei Province and for the principle that as much as possible to cover the whole industry, a total of 3000 questionnaires were issued, and the final recovery of 2037, the recovery rate of 67.90 %. In the recovered papers, the number of enterprises that have innovation activities is 895, accounting for 43.94 % of all enterprises.

22.5.2 Variable Measurement

22.5.3 Hypothesis Testing and Results

In this paper, we use SPSS17.0 statistical software for statistical analysis of the variables. Various indicators through principal component analysis (maximum variance method rotation) and reliability testing, we obtain that factor analysis results such as shown in Tables 22.1, 22.2, 22.3, 22.4. KMO sampling measure corresponding values were: 0.844, 0.794, 0.696, 0.626, 0.666; P (Sig.) all equal to $0.000 < 0.05$, these show that the data can be used for factor analysis. The cumulative variance of factor analysis were: 61.578, 62.960, 64.558, 53.365, 61.275 %, all of these are up more than 50 %. We can see the model fits well from the indicators of the model fitting, reaching the general requirements of analysis.

In reaching the main factor we used vicariate correlation analysis to do significant two-sided test, and then draw a correlation coefficient of each factor. As is shown in Figs. 22.3, 22.4, 22.5, 22.6:

H1: As is shown that the network's structure and properties has a significant positive impact on absorptive capacity, so this assumption is supported. This

Table 22.1 The design of measuring terms for variable at network-level factors

Variable	Measuring terms	Factor coefficient
A Development vision	A1 The cooperation with enterprises, universities, scientific research institutions has high consistency vision	0.624
Cooperative target	A2 Jointly establish development goals with partners refer to their resources advantage	0.676
	A3 Supervise and regulate with partners at regular intervals as plans being carried out	0.580
B Government support	B1 Government's plans and information provide important information for the enterprises' innovation	0.628
	B2 Government agencies have provided financial support for enterprise special plans	0.519
C League form	C1 Equipment, raw materials, semi-finished product supply enterprise that alliance partners have provided important information for technology innovation	0.669
	C2 And peer enterprises of strategic alliance between promote the enterprise innovation	0.609
D	D1 Has reliable cooperation partner for innovation	0.594
Trust, exchange and communication	D2Has influent channel with scientific research institutions, universities	0.681
	D3Communicate with university, scientific research institutions regularly	0.716

Table 22.2 The design of measuring terms for variable at absorptive capacity

Variable	Measuring terms	Factor coefficient
E Identification ability	E1 The investment that to search for external information knowledge	0.432
	E2 With high recognition ability for external knowledge	0.629
F Obtain ability	F1 Enterprise can quickly introduce the outside new knowledge and technology	0.572
	F2 Enterprise can positively train employees learning new skills	0.583
M	M1 Can quickly integrated new and old knowledge	0.521
Digestive ability (or transferring capacity)	M2 Can provide knowledge effectively to the internal department employees	0.629
N Application ability	N1 Have the ability that use new knowledge efficiently into the related products and service	0.993
	N2 Use new knowledge with enthusiasm and eager to create new knowledge	0.596

suggests that the government's support in the political and research cooperation need to further improve. The resources' complementary between enterprises with the ones in the same alliance needs to be further enhanced. For cooperative

Table 22.3 The design of measuring terms for variable at enterprise individual factors

Variable	Measuring terms	Factor coefficient
G Enterprise strategy	G1 Make enterprise innovation as the important strategic	0.320
	G2 The innovation strategy has pointed out the direction for enterprise innovation activities	0.638
H Knowledge stock	H1 Enterprise department store enough knowledge technology	0.913
	H2 Pay attention to the accumulation of experience	0.450
I Research activities	I1 Enterprise's science and technology research investment has take a appropriate proportion	0.913
	I2 The enterprise has does internal protection for technology secret	0.896
J Organization structure	J1 Has a sound organization	0.613
	J2 Each department has fluent information communication	0.677

Table 22.4 The design of measuring terms at enterprise innovation performance

Variable	Measuring terms	Factor coefficient
X The growth innovative performance	X1 Have a bigger number of patent than the other	0.545
	X2 New product sales revenue is higher than the other	0.557
Y The fruitful innovative performance	Y1 Has a stronger continual research and develop ability	0.635
	Y2 Improve the quality of service	0.592

strategic objectives, the companies' reorganization is relatively strong. They are able to clear their own R & D objectives with partners and their own development strategies.

H2: The test results showed that the individual capacity has a significant positive impact on absorptive capacity, this hypothesis has been supported. And it can be seen that the comprehensiveness and efficiency of the elements of the individual firm capacity can make enterprises to digest, absorb external knowledge more effectively. And corporate strategy can make a more significant positive impact for enterprise to search and access external knowledge.

H3: See from the test results, organizational absorptive capacity is positively related to innovation performance growth, and the correlation coefficient is big. This indicated that organizational absorptive capacity has a significant positive impact on the innovation performance on business growth. This hypothesis has been supported.

H4: This shows that the organizational absorptive capacity has a significant positive impact on business results innovation performance, this hypothesis has been supported. In an environment which is full of uncertainties, companies need

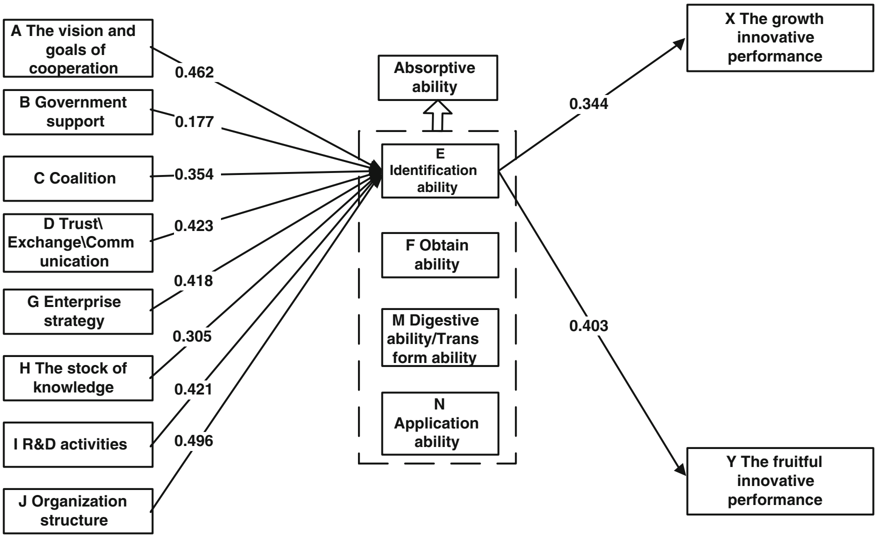

Fig. 22.3 Hypothesis test results 1

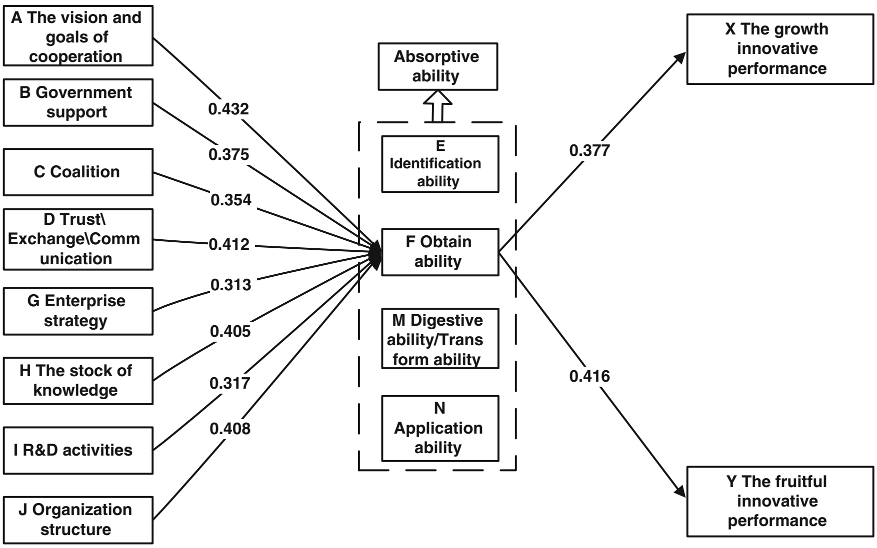

Fig. 22.4 Hypothesis test results 2

to have a keen ability to monitor the market changes and competitors, you also need to respond quickly accordingly to enhance market performance.

H5: The test results indicating that the individual firm capacity has a significant positive impact on business results innovation performance. In the ability of individual enterprises, the positive impact of the stock of knowledge and research

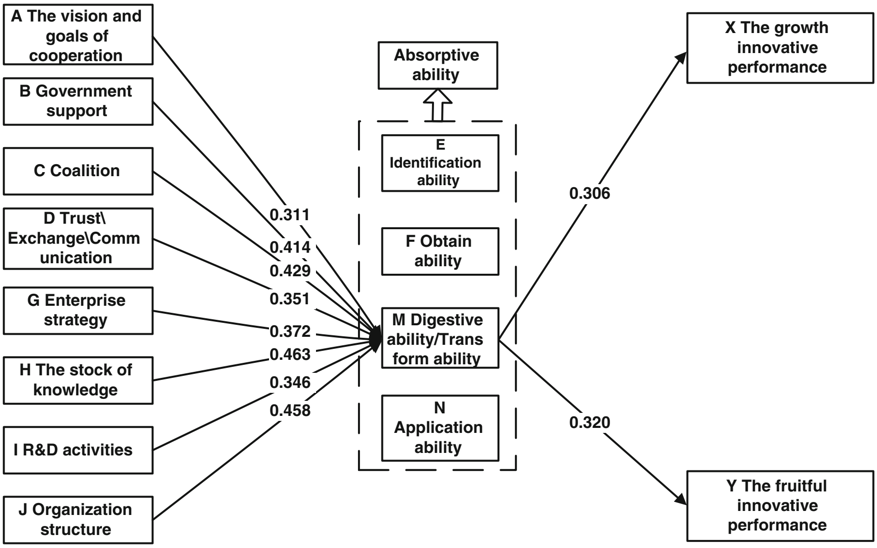

Fig. 22.5 Hypothesis test results 3

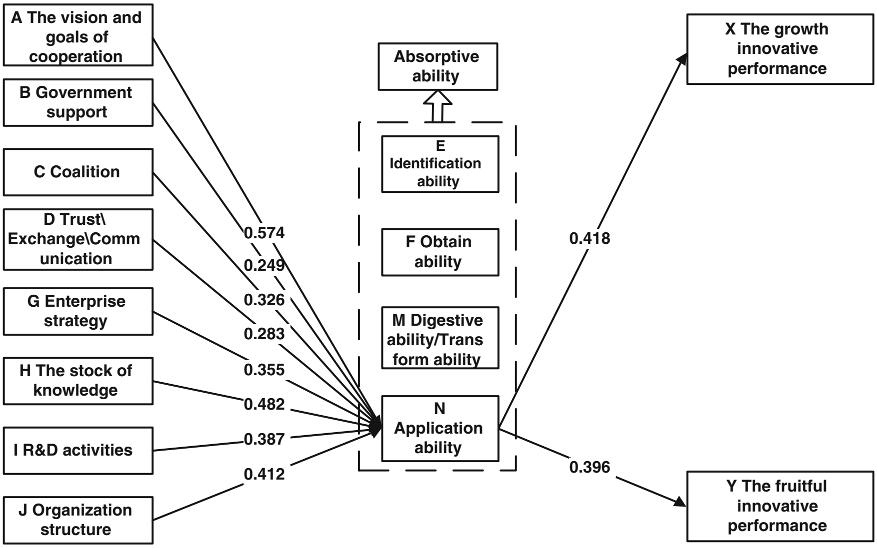

Fig. 22.6 Hypothesis test results 4

activities on the business results of innovation performance is particularly prominent. If you have the same resources, the company which has a wealth of knowledge and research skills will use resources more perfectly.

22.6 Conclusion

In the cooperation of Government Industry Education and Academy, the companies need to have the ability to recognize the value of external knowledge, but also need to have to absorb the valuable knowledge and apply it to commercial activities.

This article starting from the microscopic perspective of the enterprise to find the entry point in relations of network capacity and individual capacity–absorptive capacity, and then through the absorptive capacity this bridge to build the contact between network capacity, individual capacity and enterprise innovation performance. According the network ability to see the political and research cooperation network-level factors, anatomizing enterprise individual capacity factors, and through enterprises' absorptive capacity this springboard to study the impact on innovation performance. We draw that the enterprise should clear vision and goals of cooperation, use resources advantages between the partners rationally, through communication and exchange, trust, alliance and combined with their competitive strategy's being clear, with the knowledge capacity, R & D activities' proceeding, coordinate the internal relations among the organization structure, and promoting the improvement of organizational absorptive capacity. Then achieve better innovation performance in the growth of the enterprise itself and the results of innovation performance.

In this paper, there also have many deficiencies. First of all, in the sample selection the number of companies with the various industries is not consistent with each other. In addition the impact that the differences of industries has on enterprise absorptive capacity is not taken into account. Variable indicators' being established of scientific needs to be improved. Finally, because of the limitations of reading literature it has to be in-depth and thorough on understanding of relevant theory.

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Chapter 23
Research on Problem and Strategy for Chinese Engineering Practice Education

Shi-ying Liu, Jun-li Liu, Wei Zhang and Chao-yi Chen

Abstract As the theory of "engineering education return to practice" is getting to be accepted by many experts in engineering education field and engineering enterprises generally need workers with operation capability, engineering practice education has entered into a rapid development period. Compared with some other education types, engineering practice education has its own particularities in objects and goals so that there are lots of problems should be solved quickly. Based on the intensive study to the connotation and education procedure of Chinese engineering practice education, this paper analyzes present problems of our engineering practice education systematically from internal core, development mechanism and external appearance these three levels and also offers countermeasure proposals for these problems from system reformation, students training innovation and new technology pushing corporation these three aspects.

Keywords Engineering practice education · Problem analysis · Countermeasure analysis · Education management

Making a general observation to domestic and international engineering education development, the concept of "Science education return to the engineering and the base of engineering education is practice" was accepted by many experts in this field. American made the strategy of "return to engineering" in the last century

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S. Liu (✉) · J. Liu
Tianjin Institute of Engineering Software, Tianjin, China
e-mail: 894201297@qq.com

J. Liu
e-mail: 453102741@qq.com

W. Zhang · C. Chen
School of Management, Tianjin University, Tianjin, China
e-mail: zhangwei@htgvc.com

C. Chen
e-mail: ccy_home@hotmail.com

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eighty's, after that, a lot of Africa and Southeast Asian countries followed and achieved remarkable results. Our engineering practice education was also in a stage of rapid development in the past 10 years (Yi 2007).

In recent years, lots of experts in the engineering education area were getting to recognize that engineering practice education is very important to social and economic development so that engineering practice education were getting more and more focus (Fu 2011). With the background of Multi-type marketing demand and practice education mode, although there are some papers involve the problems and countermeasures of our engineering practice education development, but there is little paper make the comprehensive and systemic analyses. This paper will analyze present problems of our engineering practice education systematically from internal core, development mechanism and external appearance these three levels, and then offer countermeasure proposals from system reformation, students training innovation and new technology pushing corporation these three aspects.

23.1 Connotation of Engineering Practice Education

In accordance with the specific characteristics from engineering practice education to the other education types, engineering practice education can be defined as an activity that education subjects make influence on the mind and body of educated subjects with certain plan and organization in order to improve the engineering practice ability and engineering major knowledge level of students so that they could become the engineer or manager who are good for society, especially for the science and engineering major students (Shi 2007). With more and more practice education modes being innovated, the education subjects are not only a department of schools, there are also many kinds of cooperation between schools and enterprises that trained engineering students by way of engineering practice education center as the platform.

The key point of engineering practice education is practice teaching, but we should not ignore the applied theory teaching. Training objectives of engineering practice education is not only engineering technological talents but also the engineering scientists and manager, so the engineering general basic theories can be finished in the other part of engineering education and the targeted professional applied theory should be combined with engineering practice teaching as the first basic stage of engineering practice education. We could design theory courses in accordance with practice parts and check the validity and accuracy by the feedback of practice parts. The combination of theory and practice can avoid the blindness in theory learning and improve the standardization and principle. Otherwise, we should focus on the training of innovative talents who are good at engineering theory and application and choose the training mode according to the student's interesting and character (Zhang 2008). Theory learning should be started before practice learning and then we can consider the innovation, the theory is base while the practice is key point and the innovation is soul, these there points are interdependent with the influence between each other in the middle procedure, that is the procedure of engineering practice education (Zhang et al. 2007). It is beneficial to analyze the development mechanism deeply after clearing the target and procedure of engineering practice education.

23.2 The Development Problem of Chinese Engineering Practice Education

We analyze the problem of our engineering practice education from the reasons inside to the reasons outside, there are three levels reasons they are internal core level, development mechanism level and external appearance level. Researching the problems from these three levels is conducive to analyzing the crucial problem and bottleneck of our engineering practice education more deeply and completely (Fig. 23.1).

23.2.1 Internal Core Level Problem

The problems in internal core level are the most important and essential issue while problems in the other levels, in essence, all are evolving or representation of internal core level problems. It is very crucial to analyze problems deeply in this level and the base to solve the bottleneck of our engineering practice education. There are two main kinds of problem: the first one is that the education procedure is not definite and the train of thought is not clear. Engineering practice education involves three main parts: theory education, practice education and innovation education. The engineering schools or engineering practice education centers, although are carrying on the exploration of engineering practice education, but

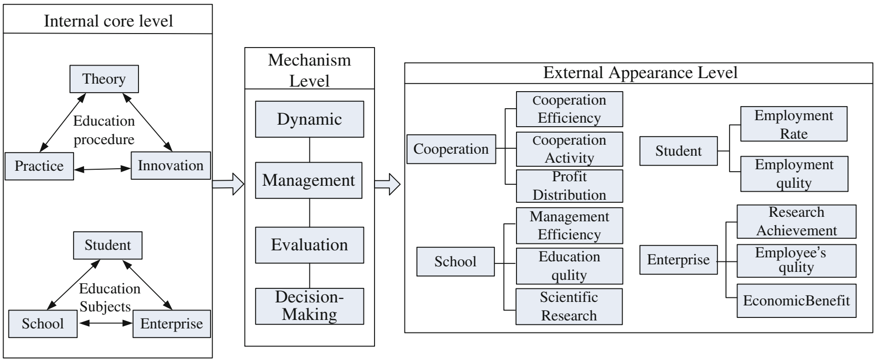

Fig. 23.1 Three levels problem of engineering practice education

most of them are just stay on the reform in teaching system or education form, such as the reform of "3 + 1" teaching, "2 + 2" teaching and "double-professional teachers", these reforms did not clear out the dialectical relation of theory, practice and innovation and innovate the education mode depends on the character of different students. Lots of colleges are carrying out the practice education in the same mode so that the students they taught are belong to same level that cannot adept the needs of society for multi-type talents. Theory is the base of practice while the practice is the verification of theory and the innovation does not only need the increase of theory but also the accumulation of practice. Basic theory should develop comprehensively, application theory should be carried out with certain target and the practice part should train students depends on their own interesting and character. For some students who have innovative thinking, we can stimulate their innovation potential further (Wang 2011). Our engineering practice education should follow the principle of people foremost in order to innovate more flexible course systems and training mode for students, the course setting cannot be limited unduly; As to the second aspect, the relationship between different education subjects is not very clear so as the cooperation between them is not very successful. Compared with the other education ways, the subjects of engineering practice education are not only students and school, but also enterprise that plays a pretty important role. At present, there are many ways of our engineering practice education platform such as the practice education centers in the school, industrial parks led by enterprises and the engineering practice education platforms built by colleges and enterprises, etc. (Hu 2009). Whatever which ways, the most important thing is that how to cultivate more excellent students and how to unified the benefits and targets of colleges, students and enterprises (Shen et al. 2011). The enterprises consider economic benefits best while the colleges consider both of economic and society benefits and the situation of students is very complicated, their basic knowledge, economic base, interesting, working inclination and even sense of worth are all different (Wu 2007). Lots of engineering practice education center didn't handle well the relationship of these three subjects so that students did not satisfy their job, the enterprise cannot recover the investment and the colleges also did not accomplish the education targets yet.

23.2.2 Development Mechanism Level

The problem in internal core level influence on the problem in development mechanism level directly. If there is no good running mechanism exists, engineering practice education would miss many chances and come up against lots of difficulties. The First aspect is dynamic mechanism. There is no good industry chain and benefit chain exists between schools and enterprises so that their lacks of cooperation enthusiasm result in inefficiency of their cooperation. The second aspect is management mechanism. The management of engineering practice education is confusing, resources integration is hard to be achieved and each administers in his own way but can't run as a whole, even lots of conflicts often occurred among them. The third aspect is evaluation mechanism. The present evaluation didn't consider the benefits and targets of all cooperation subjects. There is no objective dynamic assessment index exists and it is not easy to establish a reasonable evaluation system so that benefits distribution can't be executed fairly and efficiently. The last aspect is decision making mechanism. Because of the lacks of good decision making mechanism, the information Asymmetry and uncertain factors increase the policy making difficulties of the administrator in school or enterprise, it caused the process getting complicated and mistake rate increased.

23.2.3 External Appearance Level

The problems in the first two levels cause lots of specific problems in detail and operation level revealed directly. The concrete features in integral cooperation is that: cooperation efficiency is lower, resources cannot be integrated well, partners lack of cooperation enthusiasm, The division of labour is not clear-cut, each one being not charged with specific responsibilities, benefits distribution cannot be reasonable; in school aspect: administration efficiency is lower that causes a serious waste of resources and teaching quality decreasing causes theory and practice education stay in a lower level. The academic papers published less and the level is not high results in the development of research has remained stagnant. In student aspect: the low employment rate and quality is a very significant problem, students cannot get high salary and good prospects of development. In enterprise aspect: there are fewer results in cooperation research for the enterprises and they didn't get more new outstanding employees and also cannot return more economic interests. These specific problems are general problems in engineering practice education which influence on the sustainable development of engineering practice education.

23.3 Analysis of Chinese Engineering Practice Education Development Solution

23.3.1 Multi-Level Training Mode

According to the education procedure of our engineering practice education, it is very important to handling the relationship between theory, practice and innovation well. The most important job is practice while we cannot ignore the theory education and innovation training, the society does not only need engineering technology blue collar workers, Engineering Technology white collar managers but also engineering academician. We should teach students refer to their aptitude and interesting so that we can combine the subjects, manners, and targets of education, find a good way to train students. The students who have innovation potential should be increased more basic and crossing subjects theory courses and comprehensive practices in order to give full scope to their creative energy; the students who have the higher comprehensive ability of administration should be learned more engineering and enterprise management theory courses and practice contents so as to train their engineering ability and conscious.

23.3.2 System Innovation

Over the past decade, our engineering practice education got more and more focus and made a certain achievement rely on the policy and financial supports from government. As the developing of our engineering practice education being close to information, diversification and technology, the tradition education way of metalworking practice, school-run factory practice, double instructor cooperation and society practice can't adapt to the needs of society to professional engineering and administration person, the reform is imminent (Gao 2011). Totally, our engineering practice education must follow the principle that teaching students in accordance with their aptitude, working out measures to suit local conditions, developing base on society benefits and practice and also giving consideration to both economic benefits and innovation training (Li 2011). The detailed operating must give consideration to both inside and outside, as for the inside part, take the engineering practice education center as the cooperation platform, explore the new mode of cooperation between school and enterprise, focus on establishing the organization frame, clearing the authority and responsibility and allocating the benefits so as to working hard to the sustained development of our engineering practice education; as for the outside part, rely on the supports of government and the coordination between intermediaries, institutes and investment institutions such external subsystem, we can integrate resources and improve the development of engineering practice education. Otherwise, we should focus on the work of building demonstration center and establish multiple level innovation pilot, set the style to similar type engineering practice education center by evaluating the performance of education pilots in different construction conditions and construction modes (Huang and Zeng 2006).

23.3.3 New Technology Pushing Cooperation

The practice part of engineering practice education is the most important thing, there are more or less difficulties exit in the software or hardware operation of practice systems which different engineering major students are using. Among all the problems, such as the problems of the rapid system updating, high cost maintenance, complicated operation, worse system security and hard cooperation between multi-level procedures are the general problems of the most engineering practice major. As the science technology developing fast, the human science technology level are enhancing constantly, even some technology in some areas had a tremendous change while new technologies and products were applied. Our engineering practice education should intensively apply such new technologies to the practice courses (Yan et al. 2011).

First of all, we can develop professional practice software based on technology such as the human simulation, analog simulation three-dimensional simulation. For computer related major like software engineering can use these technologies to build simulative research and development platform and carry out practice program using simulant education software with real case. For automation related major like electrical engineering and mechanical engineering, we can use simulant practice equipment in some higher danger, faster updating or higher maintenance cost parts and apply simulative software help teaching indirectly so that simulate the whole operation process and solve the problems of security and equipment cost. Otherwise, we can build simulative share education platform while integrating every sources based on the new information technology such as cloud-computing and internet of things technology so as to avoid invest repeatedly and economize education costs (Wang and Wu 2005). As for the teaching application layer, every working procedure could be operated independently, and then integrate the engineering program and verify the results by simulation technology in order to solve complicated problems such as coordination between different places and coherence of different procedure (Tang 2011).

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Chapter 24
Research on Restraining Obstacles of Technical Knowledge Diffusing and Sharing in High-Tech Enterprises: Based on Analyzing Level Variables and Rate Variables Fundamental In-Tree Modeling of System Dynamics

Hua Chen, Lei Zhou, Deng-ke Yu and Qin Zhu

Abstract In order to clean out obstacles of technical knowledge diffusing and sharing in innovation of high-tech enterprises, forming causes of obstacles of technical knowledge diffusing and sharing are analyzed in this article, and countermeasures of restraining obstacles are put forward. A simulation model is constituted based on method of level variables and rate variables fundamental in-tree modeling of system dynamics and the validity of every countermeasure is shown and validated, and key countermeasures are found to implement emphatically in order to provide consult and reference for improving technical knowledge diffusing and sharing and innovation management capabilities.

Keywords High-tech enterprise · Method of level variables and rate variables fundamental in-tree modeling · System dynamics · Technical knowledge diffusing · Technical knowledge sharing

24.1 Introduction

With the government considering the technical innovation and self-directed innovation as the important strategy of development, the high-tech industry has gradually become the main development part of national economy. We have paid

H. Chen (✉) · L. Zhou · D. Yu · Q. Zhu
School of Mathematics and Management, Nanchang University, Nanchang, China
e-mail: Chenhuause@126.com

L. Zhou
e-mail: Zhoulei707228246@qq.com

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much attention to technological innovation in our daily life. In the technical innovation process of high-tech enterprise, it is the technical knowledge diffusing and sharing that is the key factor to innovation success. However, there are certain obstacles that have caused slow knowledge spreading and low knowledge sharing in the process of technical knowledge diffusing and sharing, and the obstacles have influenced the quality and efficiency of technical innovation. Therefore, researches on how to eliminate obstacle of technical knowledge diffusing and sharing has significant practical significance for high technical enterprise enhancing level of technical knowledge diffusing and sharing, and of innovation management.

24.2 The Concept of Technical Knowledge Diffusing and Sharing

The technical knowledge diffusing is that technical knowledge are transmitted, spread and applied by various channels during staffs. Technical knowledge is put to use by staff through diffusion gradually so that they can increase their technological accumulation and improve their technological level, and then provide condition and foundation for technical knowledge sharing. According to the principle of knowledge diffusing, if knowledge is limited to oneself personally, the utility must be decreased for them while other people haven't any social utility, only expanding the application range of knowledge, will the knowledge play a big role in social utility (Boesot 2000).

The technical knowledge sharing is that staff shares technical knowledge openly, and draws on each other's merits and raises the level together, and learns each other's good points for common progress. *Bill Gates* discourse upon the importance of the knowledge sharing in his *The Speed of Thought*, he pointed out that managers of a company must believe in the importance of knowledge sharing, or you will fail even though you have mastered knowledge excellently. And he also said that power is not coming from explicit knowledge but coming from knowledge sharing, and this idea should be reflected by the value and system of prize of a company (Gates 1999).

24.3 Causes Analysis of Technical Knowledge Diffusing and Sharing

The high-tech enterprise's scale is still small in our country today, and having many obstacles in those enterprises limit knowledge diffusing and sharing to form. Now this paper will list the obstacles as follows.

24.3.1 The Spread Obstacle of Information System

Whether convenient and unobstructed or not knowledge diffusion and sharing depend on the creation and application level of knowledge management information system. But now most of small and medium size high-tech enterprise's investment is short on network construction of knowledge management information system, they still lack assistant communication software system and database system for accumulation knowledge, which cause knowledge sharing limited (Liu and Jia 2008).

24.3.2 The Obstacle of Organization Structure

The traditional and hierarchical structure of pyramid is easy to produce the communication obstacle between the top and bottom of entire company, the strict departmentalization also causes the communication obstacle in the same rank (Xu and Huang 2008). In the rigid organization structure of grade gap and departmentalization, it is difficult to for the staff to communicate with each other conveniently, the knowledge is lost and distortion appears in the delivering process. The knowledge sharing needs a comfortable and free circumstance, but its realization is blocked by the rigid organization model.

24.3.3 The Obstacle of Exclusive Monopoly Knowledge

The obstacle of exclusive monopoly knowledge is that owners of knowledge are not willing to make it known to the public; they even try their best to control knowledge diffusing and sharing for protecting their benefits. The main three reasons listed will be as follows.

The first reason is that the cost-benefit of knowledge diffusion is dissymmetry. Whatever the knowledge is accumulation of experience from their learning and work long time, whatever it is technical knowledge innovation by oneself, all those have to be paid. The personal knowledge can create high value when it is being high utility and keeping scarcity. If the knowledge was shared, its scarcity would be corroded and its value would be lost. Therefore, the owner of knowledge must gain compensation as precondition before that the knowledge will be spread. The knowledge sharing can make someone get knowledge from others freely and gain benefit from those knowledge assets, but in our daily life, the owner of knowledge can't get compensation equivalent to the value of the knowledge. In order to get more benefits from the knowledge, they limit the knowledge diffusing and sharing as possible as they can (Xie 2006).

The second reason is that staffs always maintain their competition advantage in their enterprises. Creating competitive mechanism and implementing the survival of the fittest rules are the universal management way of increasing efficiency in the enterprise. But to a certain extent, these ways have limited formation of knowledge sharing (Jiang 2006).

The third reason is that the staff pursues prestige and right rigidly. Most of staffs high-tech enterprise are knowledge-based labor, they pursue not only success, but also prestige and right. Therefore, the technical experts always oppose knowledge sharing intensely, they worry once they lost the knowledge authority, and they would lose specialist status.

24.3.4 The Obstacle of Knowledge Comprehension

The path dependence of technical knowledge accumulation decides that the cognitive ability of people is influenced by their previous experiences and knowledge. The staff has formed habitual thinking and personal unconsciousness in the knowledge accumulation process of many years, which decide people's attitude about how to treat the new prospect of knowledge and how to choose or accept technical knowledge.

24.3.5 The Obstacle of Seeking Knowledge

The staff of the high-tech enterprise always has the strong self-esteem, they are too proud to ask for help from others, and worry themselves about what will be considered as the ignorance, and then will deny their own (Senge 2002). In order to avoid it happened, they will try their best to acquire the answer independently rather than ask for help to gain the answer quickly. What's worst, the technical expert is too pride to discuss problem with others. These views also limit the technical knowledge to move and share.

24.4 Measures to Surmount the Obstacles of Technical Knowledge Diffusing and Sharing

24.4.1 To Enhance the Construction of Knowledge Management Information System, and Set Up the Platform of Knowledge Diffusing and Sharing

The internet is channel of knowledge moving, and the knowledge management software is tool of knowledge delivering and sharing. In order to overcome the spread obstacle of information system, the organization not only enhances their intranet and extranet construction, but also pays much attention to setting up software system platform. They should combine internet and software tool to build a cooperative knowledge system that can make all aspects' experience and knowledge blend and exchanging, and transform personal knowledge into public one, change tacit knowledge into explicit knowledge, and shift external knowledge to internal knowledge by the greatest extend so as to increase the scope of knowledge twofold and improve the effect of knowledge quality.

24.4.2 To Change the Organization Structure of Enterprise into Being Flat, Flexible, Agile and Networking Form

The knowledge diffusing and sharing needs a kind of comfortable organization form to communicate conveniently. Therefore, the enterprise should change the rigid and hierarchical organization structure into flat, flexible and networking form.

24.4.3 To Constitute Learning Organization so as to Promote Circumstance Constructing of Informal Communication and Knowledge Sharing

The main contents of learning organization include establishment of a shared vision development of team learning, and improvement of thinking pattern and advocating of system thinking and so on (Jia and Ding 2002), which play an important role in promoting circumstance constructing of informal communication and restraining the obstacles of knowledge comprehension and seeking knowledge. The companies constitute a common prospect so that the personal goal and organizational goal will be high degree of unity and form strong centripetal force as well as cohesion in enterprise, then can advance that the staffs communicate and cooperate each other actively and allow others to share personal wealth of knowledge aggressively. The team learning is useful for staffs to express their views and ideas, to learn and share others' knowledge and experience so as to construct a good circumstance of knowledge communication and sharing, and make the behavior of communication and sharing become organizational convention so as to restrain the obstacles of seeking knowledge appearance effectively. It is very helpful for staffs to improve their mental model so that they can break the original thinking pattern, the system have taught the staffs to think problems systemically in all aspects, which can help the workers learn and accept new things and new knowledge, advance appearance of knowledge flow in company, and be helpful to restrain the obstacles of knowledge comprehension.

24.4.4 To Do the Inner Appraisal and Stimulation Well in Organization, and Guide the Behavior of Knowledge Sharing with Rules and Regulations

Owing to enjoying knowledge wealth exclusive, the staff consistent pattern of behavior is opposition to the requirement of knowledge sharing. But the systematization method of appraisal and stimulation can restrain the subjective obstacle effectively.

24.5 To Demonstrate and Verify on the Effect of the Measures of Restraining the Obstacles of Technical Knowledge Diffusing and Sharing

This paper will adopt level variables and rate variables fundamental in-tree modeling of system dynamics to construct a simulation model so as to demonstrate the effect of the measures of restraining the obstacles of technical knowledge diffusing and sharing, analyze the sensitivity of the measures' effect and verify the measures' validity (Smith 2008).

24.5.1 Construct the In-Tree Model of Knowledge Diffusing and Sharing

Construction the in-tree model of knowledge diffusing and sharing like the Fig. 24.1. The technical knowledge diffusing and sharing is taken as the stock variable in model, and it is affected by two flow variables that they are advancing technical knowledge diffusing and sharing varying quantity and blocking technical knowledge diffusing and sharing varying quantity, and joint function of the stock variable.

The flow rate variable, advancing technical knowledge diffusing and sharing, is affected by excitation factor, appraisal factor and learning organization factor, organizational structure factor and the use of information system, and the excitation factor is affected by three incitement's variables of material, promotion and mental for knowledge sharing. The appraisal factor depends on the importance of knowledge sharing as an index in appraisal system. The learning structure factor is affected by four variables that are the effect of improving thinking model, the level of system thinking, the level of building shared vision and the level of team learning. The organizational structure is affected by four variables that are compressed structure, flexible structure, and agile structure and networking. The factor of use of information system depends on the function of the use level of

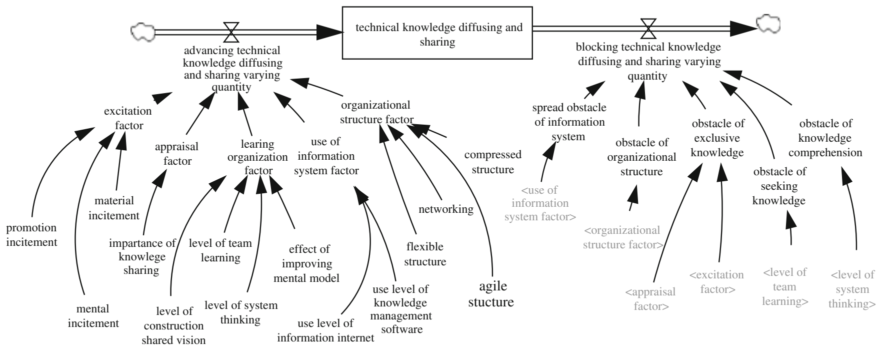

Fig. 24.1 The level variables and rate variables in-tree model of technical knowledge diffusing and sharing

information internet and knowledge management software. The varying quantity of blocking knowledge diffusing and sharing is affected by five factors that are the spread obstacle of information system, the obstacle of organizational structure and exclusive knowledge, the obstacle of seeking knowledge and knowledge comprehension. And the spread obstacle of information system is closely related to factor of use information system, the obstacle of organizational structure is closely related to factor of organizational structure, the obstacle of exclusive knowledge is affected by two factors of incitement and appraisal, the obstacle of seeking knowledge is decided by the level of team learning, the obstacle of knowledge comprehension is affected by the variable of the effect of improving thinking model and the level of system thinking. Therefore, the fundamental in-tree model was constructed by stock variables, flow variables and other variables above.

24.5.2 Create the Equations of Variables

1. Technical diffusing and sharing =advancing technical knowledge diffusing and sharing varying quantity—blocking technical knowledge diffusing and sharing varying quantity;
2. Advancing technical knowledge diffusing and sharing varying quantity = incitement factor + appraisal factor + learning organization factor + organizational structure factor + use of information system factor;
3. Blocking technical knowledge diffusing and sharing varying quantity = spread obstacle of information system + obstacle of exclusive knowledge + obstacle of seeking knowledge + obstacle of knowledge comprehension;
4. Incitement factor = w1 × promotion incitement + w2 × mental incitement + w3 × material incitement; and w1, w2 and w3 represent the weight

of variables respectively that are promotion incitement, mental incitement and material incitement for knowledge sharing;

5. Appraisal factor = the importance of knowledge sharing;
6. Learning organization factor = w4 × level of system thinking + w5 × effect of improving mental model + w6 × level of construction shared vision + w7 × level of team learning;

And w4, w5, w6 and w7 represent the weight of variables above respectively.

7. Organizational structure factor = w8 × level of compressed structure + w9 × level of flexible structure + w10 × level of networking + w11 × level of agile structure;

And w8, w9, w10 and w11 represent the weight of variables above respectively.

8. Use of information system factor = w12 × use level of information internet + w13 × use level of knowledge management software;

The w12 and w13 are the weight of two variables above;

9. Spread obstacle of information system = 1-use of information system factor;

"1" represents the maximal value of spread obstacle of information system.

10. Obstacle of organizational structure factor = 1−w14 × organizational structure influencing factor;

"1" represents the maximal value of obstacle of organizational structure, and w14 represent the counteraction rate of organizational structure influencing factor for obstacle of organizational structure influencing factor.

11. Obstacle of exclusive knowledge = 1−(w15 × incitement influencing factor + w16 × appraisal influencing factor); w16 and w17 are weight of two variables above, are assigned a value according to the effect of counteraction.
12. Obstacle of seeking knowledge influencing factor = 1−w17 × level of team learning;

The w17 represent the counteraction rate of level of team learning for the obstacle of seeking knowledge influencing factor;

13. Obstacle of knowledge comprehension = 1−(w18 × effect of improving mental model + w19 × level of system thinking);

The w18 and w19 are weight of two variables above, are assigned a value according to the effect of counteraction.

In order to assign a value to weight from w1 to w19, this paper made a questionnaire survey for managers of many high-tech enterprises, after evaluation the managers would mark the factors, and calculated the average value of all weights, finally, the weight was assigned a value as the follows.

$w1 = 0.3$; $w2 = 0.3$; $w3 = 0.4$; $w4 = 0.2$; $w5 = 0.2$; $w6 = 0.3$; $w7 = 0.3$; $w8 = 0.25$; $w9 = 0.25$; $w10 = 0.25$; $w11 = 0.25$; $w12 = 0.5$; $w13 = 0.5$; $w14 = 0.8$; $w15 = 0.8$; $w16 = 0.2$; $w17 = 0.7$; $w18 = 0.3$; $w19 = 0.3$.

24.5.3 Set the Value-Range of Variables

Due to all variables representing the level and effect of factors result in difficult quantitative analysis, therefore, this paper divided the variables range into four grades–best, better, good and not good, and every grade is represented by a fixed value as shown in Table 24.1.

24.5.4 Measure the Sensitivity Between Every Variable and Stock of Technical Knowledge Diffusing and Sharing

In this paper the method of qualitative and quantitative are adopted in combining together so as to fix value of different variables according to the grades(best, better, good and not good), and observe the effect of different value for technical knowledge diffusing and sharing. Supposed that the value of some variable is changed, the rest of values of all variables remain unchanged. Measure the sensitivity of all variables for technical knowledge diffusing and sharing as shown in Table 24.2.

In the Table 24.2, "s" is sensitivity, "A" is advancing technical knowledge diffusing and sharing varying quantity, "B" is blocking technical knowledge diffusing and sharing varying quantity, "PI" is promotion incitement for knowledge sharing, "MI" is mental incitement for knowledge sharing, "MAI" is material incitement for knowledge sharing, "AF" is the importance of knowledge sharing as an index in appraisal system, "ST" is the level of system thinking, "MM" is the effect of improving mental model, "TL" is the level of team learning, "SV" is level of construction shared vision, "FS" is level of flexible structure, "CS" is the level of compressed structure, "AS" is the level of agile structure, "NS" is the level of networking, "ISU" is use level of information system, "KMS" is the use level of knowledge management software.

The calculation result of sensitivity in Table 24.2 is according to expert advice for value of weight. The result show that every measure takes different effect for

Table 24.1 Value-range of variables

Grade	Best	Better	Good	Not good
Value	1	0.7	0.4	0.1

Table 24.2 Measure the sensitivity of all variables for technical knowledge diffusing and sharing

PI	A	B	S	MI	A	B	S
0.1	3.320	2.274	1.046	0.1	3.320	2.274	1.046
0.4	3.410	2.202	1.208	0.4	3.410	2.202	1.208
0.7	3.500	2.130	1.370	0.7	3.500	2.130	1.370
1	3.590	2.058	1.532	1	3.590	2.058	1.532
MAI	A	B	S	AF	A	B	S
0.1	3.260	2.322	0.938	0.1	2.900	2.250	0.650
0.4	3.380	2.226	1.154	0.4	3.200	2.190	1.010
0.7	3.500	2.130	1.370	0.7	3.500	2.130	1.370
1	3.620	2.034	1.586	1	3.800	2.070	1.730
TL	A	B	S	CS	A	B	S
0.1	3.320	2.550	0.770	0.1	3.350	2.250	1.100
0.4	3.410	2.340	1.070	0.4	3.425	2.190	1.235
0.7	3.500	2.130	1.370	0.7	3.500	2.130	1.370
1	3.500	1.920	1.670	1	3.575	2.070	1.505
NS	A	B	S	AS	A	B	S
0.1	3.320	2.550	0.770	0.1	3.320	2.550	0.770
0.4	3.410	2.340	1.070	0.4	3.410	2.340	1.070
0.7	3.500	2.130	1.370	0.7	3.500	2.130	1.370
1	3.500	1.920	1.670	1	3.500	1.920	1.670
SV	A	B	S	KMS	A	B	S
0.1	3.320	2.130	1.190	0.1	3.200	2.430	0.770
0.4	3.410	2.130	1.280	0.4	3.350	2.280	1.070
0.7	3.500	2.130	1.370	0.7	3.500	2.130	1.370
1	3.590	2.130	1.460	1	3.650	1.980	1.670
ST	A	B	S	MM	A	B	S
0.1	3.380	2.310	1.070	0.1	3.380	2.310	1.070
0.4	3.440	2.220	1.220	0.4	3.440	2.220	1.220
0.7	3.500	2.130	1.370	0.7	3.500	2.130	1.370
1	3.560	2.040	1.520	1	3.560	2.040	1.520
FS	A	B	S	IIU	A	B	S
0.1	3.350	2.250	1.100	0.1	3.200	2.430	0.770
0.4	3.425	2.190	1.235	0.4	3.350	2.280	1.070
0.7	3.500	2.130	1.370	0.7	3.500	2.130	1.370
1	3.575	2.070	1.505	1	3.650	1.980	1.670

sensitivity of the stock technical knowledge diffusing and sharing. Every measure is ordered in turn according to the big or small power of influence, AF, TL, IIU, KMS, MAI, PI, MI, ST, MM, CS, FS, NS, AS, SV. According to the result, the high-tech enterprise can advance knowledge diffusing and sharing doing like following measures, especial the top measure of the list. For example, performance assessment, team learning, use of information system, knowledge management software and so on, the higher grade of variable and value of weight are, the better technical knowledge diffusing and sharing are.

24.6 Conclusion

The high-tech enterprise should take measures to origin system of obstacles effectively so that obstacles of technical knowledge diffusing and sharing in high-tech enterprise will be solved. Construction simulation model based on level variables and rate variables fundamental in-tree modeling method of system dynamics can demonstrate and verify the validity of measure, and order in turn according to power of influence of measure, main implement the top measure of list so as to advance the effect of restraining obstacles of technical knowledge diffusing and sharing, and advance the innovation efficiency and quality of enterprise.

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Chapter 25
Research on the Effect of Knowledge Search on Product Innovation

Peng-hu Lu

Abstract In the open innovation era, knowledge searching promotes product innovation and competitive advantages of firms. After systematic review of some literature, this paper divides market/technology knowledge search into four types, and then discusses how firms accomplish product innovation. The research focuses on how technology knowledge and market knowledge are transformed to serve for the providing of new products and services. Finally, this research uncovers the mechanism of how knowledge search influences firms' competitive advantages building, and investigates the effect mechanism based on open innovation perspective.

Keywords Knowledge search · Market-knowledge search · Open innovation · Product innovation · Technology-knowledge search

25.1 Introduction

With the shortening of product life cycle, the 'closed' innovation activities effectively are weakened, integrating the corporate image, access to external knowledge and the organization's own resources becomes a necessary prerequisite to promote enterprise product innovation and product innovation capabilities (Grant 1996). In recent years, 'Open Innovation' is gradually concerned by management scholars and practitioners, its core idea is to encourage the search for and use of external sources of knowledge for technological innovation and new product development with the necessary knowledge to build the organization's sustainable competitive advantage (Chesbrough 2003). The company is committed

P. Lu (✉)
Business School of Central South University, Changsha 410083, People's Republic of China
e-mail: lph502@126.com

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to mining external sources of knowledge to compensate for the lack of existing technology and market knowledge in order to overcome the problem of 'Not Invented Here' and 'Not Sold Here'. Scholars research the company's existing product of Ribeiro, Sony, Canon and Toyota, development, sum up the company attaches great importance to the "know-who" knowledge, that a large number of formal and informal ways to search and get access to external knowledge sources. Knowledge search across organizational boundaries is a third competitive advantage improving way in addition to the internal R&D and external acquisitions, companies can search from a different knowledge channels, make use of external knowledge for new ideas and knowledge, and integrate these ideas to promote new products developed.

Dynamic capabilities in recent years become a hot topic of innovation and research, the emphasis on product innovation as the internal drivers of change and revival (Danneels 2002). From the theory perspective of open innovation and competitive advantage the study analyzes how corporate achieves product innovation through knowledge search, the search of the focus on technical knowledge and market knowledge absorption and converted into innovative products and services, for the ability to enhance our corporate innovation promote the success of China's manufacturing enterprises restructuring and upgrading, and even promote the 'Made in China' to 'Created in China' change has important practical significance.

25.2 Research in the Dimension of Knowledge Search in this Study

Cohen and Levinthal (1990) think that the corporate learning and ability to absorb new external knowledge depends on the enterprise has been the accumulation of knowledge, this accumulation of knowledge includes not only basic skills or a common language, but also the knowledge generated by the enterprise the R&D, marketing and manufacturing, technical training programs. Innovation activities, more and more attention to access to knowledge from external, detailed knowledge on the different users, technology and market are the key factors for success in a complex market (Laursen and Salter 2006). Researchers divide enterprise knowledge into technical knowledge and market knowledge (Song et al. 2005). The former refers to enterprises in the process of nurturing absorptive capacity in the actual exploration, transformation and development of knowledge from external access to new technologies, alternative technologies, potential entrants' technology, the latter refers to the application and commercialization of technological knowledge opportunities market information (Cassiman and Veugelers 2006). The two types of knowledge are complementary, the combination of organizational learning to improve the correlation between innovation and performance.

In order to overcome the localized search propensity, it is a necessary for business innovation to cross organizational boundaries to explore the conditions. Rosenkopf and Nerkar (2001), Katila and Ahuja (2002), empirical research indicates that enterprise development activities in technology-related fields. Localized search, companies focus on similar technologies and achieve incremental innovation, enabling businesses to become better in the current technology. This repeated focus of current technology allows companies to establish the capacity of the first order (first-order competence), and creating a competitive advantage through the cumulative capacity of the first order, but the sustained attention capacity of the first order will bring enterprise ‘rigid’ or trapped in a competency trap. ‘Ability rigid’ (Leonard-Barton 1992) or ‘competency traps’ (Levinthal and March 1993). The restrictions are due to the organization over-reliance on internal R&D capabilities and result in localized search no systematic distinction between business-specific technology development and integration of external R&D activities. Activities across organizational boundaries or cognitive boundaries will lead to explore more across borders or market boundaries and through cross-border search for new knowledge to future needs. Therefore, exploration and development capabilities to support enterprise innovation must be two types of knowledge, both through the localization of search depth of mining and use of existing knowledge, and integration of knowledge across borders to create new knowledge.

Exploratory search, which is the development of search and subsequent knowledge absorption has a different function in the use of external knowledge, exploratory stages of learning is to get the technical knowledge of the specific use main and development stages of learning is to find markets knowledge, knowledge absorption stage two types of knowledge seem as important as knowledge retention rely on the existing technical and market knowledge. Because of organizational resource constraints, in the process of innovation within the organization, a high level of knowledge to search means the low level of other types of knowledge search (March 1991). However, in the external access to knowledge process requires fewer resources, which reduces the negative impact of a high level of search process of the search process. The absorption of external technology and knowledge and ability to rely on the enterprise itself has a stock of knowledge and knowledge content, that is, a priori knowledge, but this stock of knowledge mining and knowledge content depends on the existing knowledge the extent of the depth of development (Fig. 25.1).

However, only the technical knowledge to complete the innovation, market knowledge about customers, suppliers and competitors is an important source of the organization of product innovation. Sidhu et al. (2007) from three angles of the supply, demand and competitors to distinguish between different market knowledge, exploratory search, corresponding to the knowledge of the supplier, customer knowledge and competitor knowledge. These external knowledge has an important role in guiding the enterprise product innovation, market knowledge after the screening after the knowledge to become an important source of business innovation (such as reverse engineering, competitive intelligence, etc.), and ultimately help to build sustainable competitive enterprises.

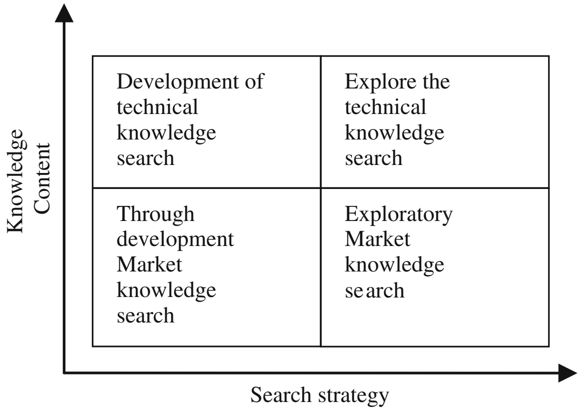


Fig. 25.1 Dimension partition of corporate knowledge search

25.3 The Way of Knowledge Search Inflecting Product Innovation Performance

25.3.1 The Way of Technical Knowledge Search Inflecting Product Innovation

Relevant technical search of the literature showed that the depth of the knowledge base for enterprise knowledge integration to provide a better place, thereby increasing the innovation performance. The search capability is different from the learning ability, learning ability mainly refers to the development of absorption of the ability of the current knowledge, problem-solving skills on behalf of the ability to create new knowledge. When companies plan to develop new products, it faces three choices: (1) through internal R&D activities to create new knowledge elements; (2) search for a new link in the current knowledge base; (3) organization external search for new knowledge elements to replace the old elements in the knowledge base.

With the increasing speed of the external competitive environment of change and technological innovation within the enterprise's technology and economic sub-optimal method will go beyond the dominant technology, and stimulate the leading technology degradation. And enterprises to overcome the trend of the diminishing return on investment of a particular technology, it is necessary to search a variety of technological paradigm (technological paradigm) (Dosi 1982). Because of the complexity of new products, product innovation needs to integrate a variety of technical knowledge of search width is a measure of the ability of the enterprise knowledge integration range. Explore the knowledge search (the width of the search) will promote the use of new knowledge to develop new products and technologies and to expand the capacity of enterprises in other technical areas. First, new knowledge test will be expanded enterprise search, and create more opportunities for new product innovation. Secondly, the elements of the new knowledge for the future exploratory search to create more opportunities for exploratory search will have more opportunities to integrate other technologies. Again, by acquiring new knowledge to avoid the 'core rigidity' and technical search can help companies to update the technical knowledge to maintain sensitivity to changes in the external environment.

Today even large companies cannot rely entirely on internal knowledge source to finished product innovation, many businesses through franchising, R&D outsourcing, mergers and acquisitions and employment of R&D personnel access to the organization and external knowledge. Marginal returns due to the external knowledge acquisition strategies of internal know-how knowledge. The same time, the external principle of knowledge may be to balance the efficiency of internal R&D activities, through the acceptance of external ideas and knowledge in order to overcome the "not place the invention" syndrome. Based the above research, we can get the hypothesis:

Hypothesis 1: Technical knowledge search will be positively related to product innovation.

25.3.2 The Way of Market Knowledge Search Affecting Product Innovation

Knowledge of the market is about the information of order and structure (Li and Calantone 1998), knowledge about the customer and competitor knowledge is the most important two types of market knowledge. Evolving customer needs and expectations over time, companies need to continue to provide high quality products and services to respond to dynamic market needs, to adopt a market orientation strategy. Market-oriented organizational level market intelligence, in different sectors absorbs the information, and respond to organization-wide. The customer has a lot of experience and understanding of the products can not be articulated, consumption habits, the potential demand for tacit knowledge, knowledge enterprises to cultivate their core competitiveness and build dynamic capabilities of key resources. Gebert et al. pointed out that the customer knowledge, including three types: customer knowledge (Knowledge about the customers), from the customer's knowledge (Knowledge from the customers) and customer knowledge (Knowledge for the customers). Enterprises will be followed by progressive mining and development of in-depth customer knowledge, the first Humanities and statistical information to understand the customer's historical purchasing information to help businesses and accurate analysis and positioning of client resources, personalized marketing and innovation; through market research, customer participation to obtain customer feedback from businesses or competitors' products and services, such information can guide companies to quickly respond to dynamic changes in customer demand (Von Hippel 1986).

Knowledge of customer needs to understand the main exploratory search behavior to achieve through market knowledge, such as leading user research, market survey, market experiments, market intelligence gathering. Passed by the enterprise, the company's products, services and market conditions and knowledge to customers to help customers better understand the company's products and services to match customer needs and business products. More than the ordinary functions of the product leading customer demand for the product, they find fault with the product, demand for products or use more advanced, willing to cooperate with enterprises that are a commitment to product innovation, enterprise information. Not satisfied with the current product, potential customers, they become depth the concerns and opinions of the enterprise product development and improvement of existing products, power. The typical customer is the main buyer of the enterprise products, their purchasing power to consider or are using the products, product improvements and to improve some ideas and opinions. However, how to make the knowledge of customer needs while meeting the universality of the customer's needs and personality needs, the balance between breadth and accuracy need to focus on development and exploration of market knowledge. Market knowledge search strategy changes with the environmental scene, Kohli and Jaworski put forward three environments that link to market knowledge search and the performance (market volatility, environmental turbulence, and the environment competitive). Market volatility refers to the speed of the customers and their preferences change. Organizations often modify products and services to meet customers changing needs in a turbulent environment. Based the above research, we can get the hypothesis:

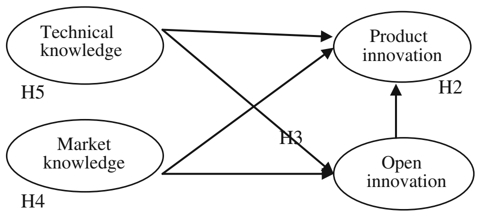
Hypothesis 2: Market knowledge search will be positively related to product innovation.

25.4 Mechanism Analysis of Knowledge Search' Effect on Product Innovation Performance

25.4.1 Analyzing From the Perspective of Competitive Advantage Theory

As Peter Drucker said, the only unique resource is knowledge to corporate. The enterprise is the combination of the heterogeneity of knowledge, tacit knowledge that can not be imitated become a lasting source of competitive advantage (Prahalad and Hamel 1990). Prahalad and Hamel (1990) the enterprise's core competence is the accumulated knowledge of an organization, including in particular the coordination of different production skills, the combination of knowledge (Eisenhard and Martin 2000).

Fig. 25.2 Proposed model factors affecting product innovation



25.4.2 Analyzing From the Angle of Open Innovation

Enterprise technology innovation is a found that the customer requirement and seek solutions of the process, the core of the solution is to obtain and comprehensive utilization of innovation resources. In the open innovation mode, the flow of innovation resources crosses the boundary of firm, found that, to gain and use enterprise external technical knowledge and market knowledge is an important task of enterprise innovation, and search for knowledge is an effective means of external knowledge. Open innovation different from the traditional innovation mode remarkable characteristics is to make full use of technology and the market information, including the external innovation source, the enterprise more tend to users, suppliers, universities and research institutions, network innovation communities outside related party cooperation, to obtain a more economical and feasible design new products or product technology.

The enterprise of the previous relevant knowledge enables it to know new information and the potential value of the digestion absorption, and used in commercial purposes. These knowledge accumulations can not only increase the storage capacity of a new knowledge, and can increase the ability of memory and application of knowledge.

From the above analysis, we can get the following hypothesis:

Hypothesis 3: Technical knowledge search will be positively related to open innovation.

Hypothesis 4: Market knowledge search will be positively related to open innovation.

Hypothesis 5: Open innovation will be positively related to product innovation.

We get the above hypothesis into one figure (Fig. 25.2).

25.4.3 Measures and Data Collection

A questionnaire is designed to capture technical knowledge search, Market knowledge search, product innovation, and open innovation. Questions relating to demographics are kept to a minimum and only age, gender and usage patterns are

Table 25.1 Profile of respondents

Demographic characteristics	Percentage	Demographic characteristics	Percentage
Gender		*Age*	
Male	65.3	≦25 Years	5.7
Female	29.2	25–35 Years	30.3
Missing	5.5	35–45 Years	46.2
Total	100	≧45 Years	15.7
		Missing	2.1
		Total	100
Occupation	Percentage	Household income	Percentage
Corporate workers	34.1	≦1,500 Yuan	14.3
Government workers	40.7	1,500–3,500 Yuan	39.3
Peasants	10.6	3,500–4,500 Yuan	23.6
Free occupation	10.0	≧4,500 Yuan	18.5
Missing	4.6	Missing	4.3
Total	100	Total	100

asked for. Questions are adapted from a variety of sources. Seven-point Likert-type scales (1 = totally disagree to 7 = totally agree) are used for all items.

Data for this study is gathered by primary data collection method through a consumer survey in Hunan, Shanxi, Shanghai, Zhejiang and Guangdong provinces in China. After half and one months, 346 questionnaires are collected. However, only 298 of the questionnaires are useable. Demographics of the participants are shown together in Table 25.1.

25.4.4 Findings

The findings are reported in Table 25.2. From the data analysis, the structural model fit to the data is acceptable. We find H1, H2, H3 and H5 are supported.

Table 25.2 Proposed Structural Model Estimation Results

Hypothesis	Path parameter	Result
H1	0.46**	Supported
H2	0.27*	Supported
H3	0.21*	Supported
H4	−0.031	Not supported
H5	0.38**	Supported
$\chi 2/\mathrm{df} = 6.795$; $P < 0.01$; CFI = 0.891; GFI = 0.924; AGFI = 0.824; IFI = 0.890; RMR = 0.095		

Note **$P < 0.01$, *$P < 0.05$

25.5 Research Summary and Prospect

This research is combined with competitive advantage theories and developing innovation theory perspective, based on enterprise external search situation at different search strategies to competitive superiority of the forming mechanism and the influence of the product innovation of path, explain different search strategies of different types of innovative mechanisms and performance conduction process.

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Chapter 26
Research on the Performance Evaluation of Enterprise Knowledge Management Within Clusters Based on BSC

Guang-ling Li and Yu Liu

Abstract After analyzing the feature and concept of industry cluster and simply summarizing the application of BSC on the performance evaluation of enterprise knowledge management, we explore the application of BSC on the performance evaluation of enterprise knowledge management inner industry cluster from the perspective of improving industry cluster competitive and put forward a the performance evaluation of enterprise knowledge management system combining industry and the feature of BSC. The results in this study will provide a new and effective method for the performance evaluation of enterprise knowledge management within clusters.

Keywords BSC · Industry cluster · Knowledge management · Performance evaluation

26.1 Introduction

In today's competitive environment, effective integration and communication of knowledge of all enterprises in the industrial cluster is the fundamental guarantee for the entire industry cluster to achieve sustainable development, enhance the response and innovation capabilities. However, knowledge management process that sets the acquisition, integration, storage, transfer, innovation and the application as one is effectively platform to ensure the conversion and application of the knowledge. Therefore, evaluation of the performance of enterprise knowledge management in the context of industrial clusters can improve and enhance all the aspects of the knowledge management. As a result, enterprises within the

G. Li (✉) · Y. Liu
School of Economics and Management, Beijing Information Science and Technology University, Beijing, China
e-mail: lgl-0546@163.com

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cluster communicate and exchange knowledge effectively, which has important theoretical and practical significance for the clusters to get sustainable competitive advantages.

In the increasingly competitive business environment, the only way to maintain competitive advantage is knowledge management (KM). With the emphasis on increased levels of knowledge management, many companies have begun to improve knowledge management to the height of the Strategic Enterprise Management, and the Balanced Scorecard as the extensive application of organizational performance assessment methods, have gradually been used as a knowledge management evaluation method by enterprises. Moore et al. designed a balanced scorecard model for knowledge-based enterprise, integrated traditional and non-traditional performance measurement indicators. Arora applied BSC in the Implementation of knowledge management and proposed that the enterprises that apply BSC in their knowledge management are more likely to succeed. What's more, BSC also be seen as an important tool for the measurement of intellectual capital. Kaplan and Norton proposed a matching method of intangible assets and corporate strategy, they integrated BSC and KM by proposing a framework in which BSC guide the intellectual capital creation, formation and measurement.

In recent years, domestic scholars have done a lot of researches on BSC's application in enterprise knowledge management. Hong (2003) did an empirical research on enterprise knowledge management based on the BSC from the point of enhancing enterprises' value, and combined the research with the reality of Taiwan's small and medium-sized accounting firms, to initially explored knowledge management performance evaluation index based on BSC. Liu (2004) proposed that the BSC can be used in management of knowledge chain; Liu and Wang (2005) integrated Balanced Score Card with Knowledge management in their study, what's more, they proposed the concept of Knowledge balanced score card and established a Knowledge Management Balanced Scorecard model. Chen and Chen (2007) built an relatively complete index system with the combination of the balanced scorecard and fuzzy math, and applied it to knowledge management performance evaluation practice. Fan (2007) built an enterprise's knowledge balanced score card which can evaluate enterprise's knowledge management performance comprehensively, he also verified the model through analyzing real case in the research. Wen and Yang (2008) built the knowledge management effectiveness evaluation model with Balanced Score Card, in which some indicators difficult to be quantified were evaluated and index system was completed. Zhang and Wu (2010) did a more in-depth study on the knowledge of the Balanced Scorecard model with University administration's reality.

Thus, knowledge management based on Balanced Scorecard is a hot issue which is studied by domestic and foreign scholars in recent years, and research achievement continue to emerge, but obviously, theoretical researches are much more than empirical researches. This paper take BSC as a management tool to explore the way to evaluate the knowledge management performance of enterprises within clusters from the point of enhancing the cluster's competitive advantages. This study can help to get more accurate evaluation of enterprises' external environment and external effects generated by the enterprise knowledge management, which will help to optimize the knowledge management process, find out the key factors that affect the enterprise knowledge management performance within clusters and enhance the competitiveness of industrial clusters as well as its level of knowledge management.

26.2 The Characteristics of the Knowledge Within Industrial Clusters

The knowledge process of enterprises within industrial clusters are different from the external enterprises, such as, knowledge‘s acquisition, sharing, application, innovation, accumulation and others, especially the process of acquisition, sharing, innovation, the internal have some advantages. However, as one in clusters, enterprise knowledge management practices should take into account the impact on other enterprises within the cluster, so every enterprise should evaluate knowledge management performance in order to promote the competitiveness of industrial clusters. Mainly there features about the enterprise knowledge management based Industry cluster as follows:

26.2.1 Knowledge Resources are More Likely to Acquire

Enterprises within the cluster have certain advantages in knowledge acquisition to the cluster enterprises outside, because the knowledge internal is easy to acquire (Kaplan and Norton 1993). Industrial clusters usually attract a variety of talents, technology and capital and other resources for innovation to the same place, on the one hand, the internal enterprises get the talents needed easily; on the other hand, enterprises in the same industry or in the same industry chain can carry out more technical exchange and project cooperation to reduce the co-operation cost (Arthur Anderson Business Consulting 1999). And perfect and centralized industrial system can strengthen the research efforts on the related industries, at the same time knowledge spillovers make enterprises easier access to relevant technology. So, the enterprise within cluster should make full use of the advantages of the available cluster knowledge resources, and make full use of knowledge resources within the cluster, to improve their competitiveness.

26.2.2 Knowledge Spillovers is Much More Obvious

Knowledge spillovers in industrial clusters are more obvious, and industrial clusters can promote the spread and diffusion of the knowledge and technology in the industry. Enterprises within each cluster are both competing and mutual cooperation, and both imitation and beyond each other. The frequent contacts and exchanges increase the transparency of the operation, so that the dissemination of knowledge within the cluster faster and spillovers increase. Many knowledge-sharing behaviors happen in the case of enterprise unconscious.

26.2.3 Cluster Environment Promote the Knowledge Innovation

Industry clusters can create a vibrant competitive environment. Competitive pressures of similar enterprises in competitive pressures constitute the innovative power of industry cluster; and transparency between enterprises of cluster tends to much higher than the enterprises external. The knowledge creator within such clusters can obtain huge profit through the creation of knowledge and marketing knowledge products. So driven by the interests, the leading enterprises will increase the positive of knowledge creation, which will promote enterprises in the cluster to make knowledge innovation. The advantages of corporate knowledge resources within the cluster are complementary, so knowledge transfer will become the bridge of enterprises innovative in clusters. All above greatly improve the knowledge innovation within clusters.

26.3 Performance Evaluation of Enterprise Knowledge Management Based on Industrial Clustes and BSC

26.3.1 The Determination of the Index System

At present, the understanding and use of BSC dimensions in all the existing researches are too rigid, most of them are in strict accordance with the Balanced Scorecard at four levels, namely financial, customer, internal business processes, learning and growth, to design a proper and complete evaluation index system, giving different weights to form a performance evaluation system. In Balanced Score Card Kaplan and Norton point out that four levels of the balanced scorecard have been actually used in all walks of life, but enterprises should take them as a model not a shackle, actually according to the company's industry position and business strategy one or more additional level is necessary (Fan 2004). Balanced

Score Card doesn't have clear dimension setting principles, so many scholars set index system according to four dimensions, but setting the dimension of the evaluation system should base on the content as well as the company will be evaluated because that the four dimensions is not necessarily suitable for all performance evaluation system (Diamantopoulos 1999).

This study is based on industrial cluster as the background, the performance evaluation is also committed to maintain and enhance the competitive advantage of industrial clusters. Compared with general enterprise, enterprises within the industry cluster are heavily influenced by the cluster environment. Cluster environment play an important role on the impact of enterprise behavior and performance, different measures will be taken by the enterprise in different clusters (Shahin and Mahbod 2007). Enterprise in different clusters implements the same.

The enterprise take different Measures, its income tends to have large differences. Therefore, in order to evaluate the performance of knowledge management effectively, not only the four dimensions should be evaluated, the cluster's environment and policies also should be evaluated. If the cluster has not promulgated policies to encourage enterprises to carry out knowledge management, not even provided with environmental conditions for the implementation of knowledge management (O'Dell 1996). The enterprise cannot achieve good performance even if it devotes considerable efforts in knowledge management. So in the industrial cluster environment, enterprise knowledge management performance evaluation system based on BSC should take the "Cluster environment" dimension into account, improved BSC framework, shown in Fig. 26.1.

And because of the external effects in the knowledge management practices in clusters, the flow of knowledge is no longer confined to the internal, so indicators in four dimensions require appropriate changes, especially the two dimensions of internal knowledge management processes and learning and growth. Therefore, this indicator system not only increase the cluster environment dimension U1,in addition, it set up knowledge alliance indicator U41 and cooperation with other businesses within the cluster U45 in the perspective of internal knowledge management processes U4; and U55 in the perspective of learning and growth U5. All changes are aimed at a more precise evaluation of the knowledge management of enterprises in the cluster (Rossett and Marshall 1999).

This article draw on the idea of the Balanced Scorecard, combined with the characteristics of enterprise knowledge management within industrial clusters, and strive to follow the principles of systematic, scientific, comparability, operability, etc., established enterprise knowledge management performance evaluation index system based on industrial clusters and BSC from five perspectives: the cluster environment, customers, financial, internal KM processes, learning and growth, shown in Table 26.1 (Gordon and McCann 2000).

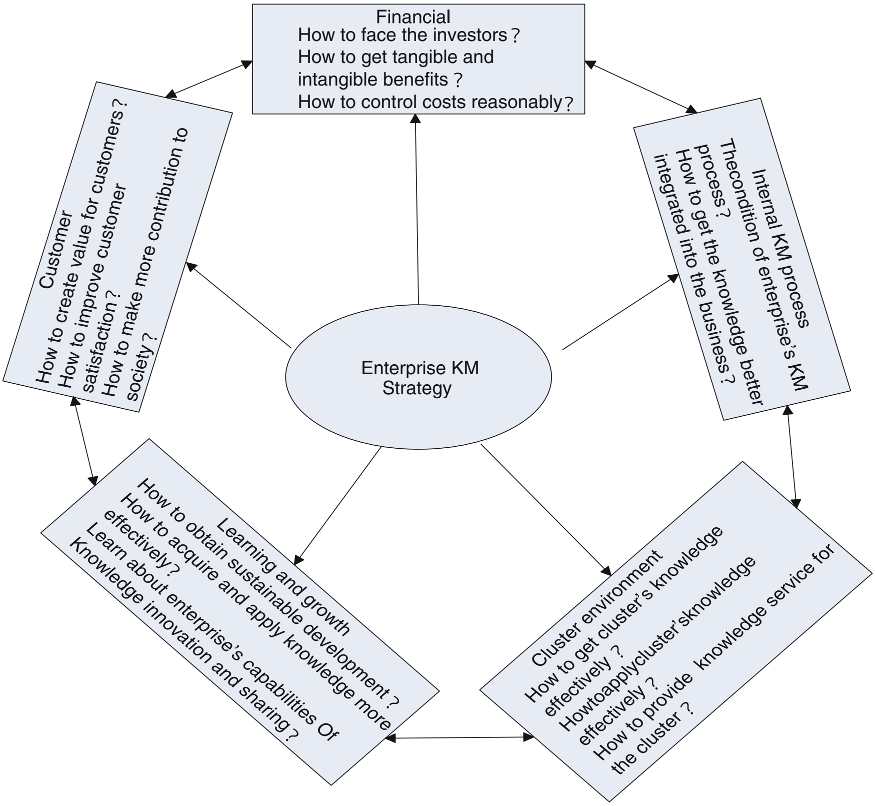

Fig. 26.1 Improved BSC framework

26.3.2 Knowledge Management Performance Evaluation Model

Model is a brief description of the kind of objective things, imitation and abstraction, there are many kinds of commonly used models, and fuzzy comprehensive evaluation method is used in this research. The specific procedure is as follows:

1. *Establish the evaluation index set*

Establish the evaluation index set by the above knowledge management performance evaluation index system.

The second-level index set:

$U_1 = \{U_{11}, U_{12}, U_{13}, U_{14}\}$
$U_2 = \{U_{21}, U_{22}, U_{23}, U_{24}, U_{25}\}$
$U_3 = \{U_{31}, U_{32}, U_{33}\}$

Table 26.1 Enterprise knowledge management performance evaluation index system within clusters based on BSC

Perspective	Indicator
Cluster environment U_1	The number of universities and research institutions U_{11}
	The number of enterprises U_{12}
	Reward and punishment mechanism related to KM U_{13}
	Policy enforcement U_{14}
Financial U_2	Profit margin on net assets U_{21}
	Annual sales U_{22}
	Recruitment and training costs U_{23}
	Sales revenue of new products U_{24}
	R&D expenses U_{25}
Customer U_3	Market share U_{31}
	Customers satisfaction degree U_{32}
	Customer retention U_{33}
Internal KM processes U_4	Knowledge alliance conditions U_{41}
	Database construction and application level U_{42}
	The convenience of network resources U_{43}
	Knowledge management institutions U_{44}
	Cooperation with other enterprises U_{45}
	KM rules and regulations U_{46}
Learning and growth U_5	Knowledge update U_{51}
	Enhancement of professional skills U_{52}
	Support for staff's further study U_{53}
	The success rate of new product development U_{54}
	Wishes to participate in cluster activities U_{55}

$U_4 = \{U_{41}, U_{42}, U_{43}, U_{44}, U_{45}, U_{46}\}$
$U_5 = \{U_{51}, U_{52}, U_{53}, U_{54}, U_{55}\}$

2. *Determination of the facts in comprehensive evaluation*

This paper uses five-level comment set, in order to quantify the qualitative indicators, each level is assigned a score, and the score of every level is as follows: V_i (i = 1, 2, 3, 4, 5), $V_1 = -2$ (Worse), $V_2 = -1$ (Bad), $V_3 = 0$ (Moderate), $V_4 = 1$ (Good), $V_5 = 2$ (Excellent), so $V = \{-2, -1, 0, 1, 2\}$ represents (Worse, Bad, Moderate, Good, Excellent).

3. *Determination of index weight*

The determination of index weight is very important in the whole process of evaluation; different weights will lead to different evaluation results, so the accuracy of the weight must be ensured when select the weight setting method (Ingley 1999). There are many common weight setting methods, such as expert scoring method and Analytic Hierarchy Process (AHP), the model in this paper will use Analytic Hierarchy Process to set index weights.

Suppose that the first-level index Ui's weight value is b_i (i = 1, 2, 3, 4, 5), and the second-level index's weight value is b_{ij} (i = 1, 2, 3, 4, 5; j = 1, 2,….,k) k = 3, 4, 5, 6.

The first-level weight vector is:

$B = (b_1, b_2, b_3, b_4, b_5)$, $0 \le b_i \le 1$, i = 1, 2,…,5, $\sum_{i=1}^{5} b_i = 1$

The second-level weight vector is:

$Bi = (b_{ij})$ (i = 1, 2, 3, 4; j = 1, 2,…k), $0 \le b_{ij} \le 1$, $\sum_{j=1}^{k} b_{ij} = 1$

4. *Comprehensive evaluation*

If the number of the experts that form the assessment team is n, and every expert has a weight for the evaluation result, and the index U_{ij}'s rank which is given by expert is

r_{ijp}, so the weighted average rank is: $r_{ij} = \sum_{p=1}^{n} r_{ijp} * \omega_p$ (i = 1, 2, 3, 4; j = 1, 2,…k)

The second-level weight vector is: $B_i = (b_{ij})$

And the second-level comprehensive evaluation result is: $W_i = \sum r_{ij} * b_{ij}$ (i = 1, 2, 3, 4; j = 1, 2,…k)

The evaluation matrix (membership matrix) on U is: $W = (W_1, W_2, W_3, W_4, W_5)$ T, and the weight vector is: $B = (b_1, b_2, b_3, b_4, b_5)$ then we obtain the comprehensive evaluation matrix of U, which is

$$E = B \cdot W.$$

The final result E is the enterprise knowledge management performance evaluation score, Enterprise knowledge management condition can be determined by this result, and if continue to analyze the second-level index, we can find the weak links in enterprise knowledge management and the successful knowledge management practices. For the industrial cluster, its environmental problems of knowledge management can be identified by analyzing the evaluation result U_1, what's more, according to the second-level index result, it's easy to see whether the enterprise take full advantage of the cluster knowledge.

26.4 Conclusion

For the performance of knowledge management has not yet formed a unified evaluation system, and the study about enterprise knowledge management performance evaluation based on industrial clusters is nearly blank, so this article try to evaluate the performance of knowledge management for enterprises in the cluster on the basis of BSC to make sure the industrial cluster's competitive advantage will be maintained and its competitiveness will be enhanced. The construction of the index system and research in this article can provide some help for the evaluation of enterprise knowledge management in industrial clusters, improve the utilization of knowledge within the cluster and optimize the process of enterprise knowledge management, ultimately enhance the competitiveness of the cluster. However, due to the complexity of the knowledge management, this index system and evaluation method should be further improved.

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Chapter 27
Research on the Relationship Between the Energy Resource Endowment and Industrial Structure Based on PVAR Model

Hai-bing Wu, Yan-qiong Zhou and Xin-xin Wang

Abstract Through constructing the Panel Vector Autoregressive Model (PVAR Model) of energy self-sufficiency rate and the proportion of the industrial added value in GDP, this article has analyzed the relationship between the industrial structure which expressed in the proportion of the industrial added value accounted for the GDP and energy resource endowment which expressed in energy self-sufficiency rate. According to the analysis results of PVAR Model, this article believes that the relationship between industrial structure and energy resource endowment is stable and notable, but the mutual influences of both parties all have time lag. The growth speed of energy self-sufficiency rate could positively influence on the growth range of the proportion of the industrial added value in GDP. The influence of energy endowment's impulse on the change of industrial structure would reach a maximum in the fourth year. Industrial structure's change also positively influence on energy endowment.

Keywords Energy resource endowment · Industrial structure · PVAR model

27.1 Introduction

From the development process of world economy, it shows that economic development of various countries all greatly dependent on energy. The growth rate of world economy has been improved significantly, therefore, the demand for

H. Wu (✉) · Y. Zhou
Economic and Management Department, Xiangnan University,
Chenzhou 423000, Hunan, People's Republic of China
e-mail: whbxnxy@163.com

X. Wang
Economic College, Renmin University of China, Handian
100872, Beijing, People's Republic of China

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energy is increasing sharply correspondingly, and the dependence of the energy resource endowment is also growing. For a single country, while the economic development is closely related to the changed of energy resource endowment, the dependence of the energy resource endowment in different development stages are different. Take China as an example, due to different natural conditions and the changes of exploitation situation, the energy resource endowment varies in different stages. Also because of the vast territory and abundant resources, the relationships between the economic development and energy resource endowment in different regions of China are possibly inconsistent. Currently China is at a critical stage of transformation. As an important part of economic transformation, industrial structure transformation is responsible for the crucial task of economic transformation, so the future industrial development should trend to be clearer (Zhou 2008). Therefore, definite the relation between the economic development and energy resource endowment in different regions of China will contribute to a clearer understanding of China's economic development.

27.2 Data Resources and Situation Analysis

27.2.1 Data Resources

The data resources of this article are "China Energy Statistical Yearbook" and "China Statistical Yearbook". And the data consist of the panel data of China's 31 provinces and autonomous regions from 1995 to 2009.

According to the main statistical index of "China Energy Statistical Yearbook", total production of energy means the sum of primary energy production of the whole country (region) in a certain period; it is the gross index used to observing the whole country (region)'s production level, scale, composition and developmental speed of energy. Primary energy production includes coal, oil, natural gas, electricity, nuclear power and power generation of other energy (wind energy, geothermal energy and so on). But it excludes the consumption of low-caloric-value fuels production, bioenergy and solar energy, as well as the secondary energy production which converted by primary energy production (Zhao and Yu 2007). Energy consumption is a gross index which be used to calculate the energy consumption of each industry and household energy consumption. Total production of energy could be divided into 3 parts, which are final energy consumption, energy loss in the process of conversion, and energy loss.

Translating the production and consumption of four kinds of primary energy into the production of million tons of standard coal, it can get the comparable total production and consumption of energy (Research group of Chinese input and output institute 2007).

Because the data of Chongqing, started from 1997, are different with other provinces, this article will put Chongqing's energy production and consumption into Sichuan. Moreover, due to the lack of Tibet's related data, Tibet won't be considered in this article.

27.2.2 Situation Analysis

27.2.2.1 Energy Production

From each year's statistical data, it can be seen that the whole country's spatial pattern of energy production has changed greatly from 1995 to 2009 (Ren and Li 2008). Generally, there is a substantial increase in the average energy production of the whole country; and the energy productions of all provinces were keeping increasing from 1995 to 2009. From the spatial pattern, the energy production of Shanxi is always at the forefront in China, and Inner Mongolia has a larger growth in energy production; the energy production of Shaanxi, Henan, Shandong and Heilongjiang all maintain high level; only the energy production of Beijing and Heilongjiang decreased; and Tibet, Beijing, Shanghai and Guangxi have the lowest energy production. Moreover, decentralized trend was shown in the spatial pattern of energy production. The energy production mainly concentrated to the central and western regions; however, the level of energy production of China's eastern region was generally decreasing.

From the proportion of each provinces' energy production to the total production of the whole country, there are substantial changes from 1995 to 2009. The biggest changes happened in Inner Mongolia, Heilongjiang and Shaanxi. It worth mentioning that this proportion of Inner Mongolia increased most, on the contrary, Heilongjiang decreased most. Although Shanxi's proportion has decreased, its energy production is still at the forefront in China, but a little bit less than Inner Mongolia in 2009. However, the proportion of energy production of Hainan, Shanghai, Beijing, Qingdao, Guangxi, Zhejiang and Fujian always are always smaller than other provinces.

27.2.2.2 Energy Consumption

The energy consumption has also changed greatly from 1995 to 2009. Provinces consumed most energy concentrates in the eastern region. Shandong, Jiangsu, Hebei and Guangdong are always in the first gradient position of the energy consumption, followed by Henan, Shanxi, Sichuan, Lining and Zhejiang. The energy consumption of Hainan, Qinghai and Ningxia is smallest. From the spatial pattern of energy consumption, decentralized trend was shown. Energy consumption of some provinces in eastern, western and central regions was gradually increasing. Major energy consumption provinces trended to a wider distribution from 1995 to 2009.

In terms of the proportion of each province's energy consumption to the total consumption of the whole country, the greatest changes are in Shandong and Inner Mongolia, which all increased substantially from 1995 to 2009. Liaoning, Guangdong, Shanxi and Heilongjiang also had big changes in this respect. Excepting Guangdong, the proportions of other three provinces all decreased. The proportions of other provinces kept stable, or varied in a very small range (Zhang 2011).

27.2.2.3 Energy Self-Sufficiency Rate

Energy self-sufficiency rate is the proportion of energy production to energy consumption in a certain region. The formula is giving below:

$$SR = P/C * 100\,\%$$

where,

SP represents Energy self-sufficiency rate;
P represents energy production;
C represents energy consumption.

Take the classification criteria for self-sufficiency rate of China's petroleum resources, proposed by Zhao and He (2006); this article divides China's energy area into four types:

When SR $\approx$ 100 %, that is P $\approx$ C, the area is basically self-sufficient area;
When SR $\approx$ 50 %, that is P $\approx$ 2C, the area is half self-sufficient area;
When SR < 50 %, that is P < 1/2C, the area is called net recharge area;
When SR > 100 %, that is P > C, the area is called net disbursement area.

According to the classification criteria of energy resources mentioned above, it can be seen the changes of China's energy resource endowment from 1995 to 2009 (Table 27.1). Because in 2009 the energy self-sufficiency rate of Shandong is 95.02 % and the energy self-sufficiency rate of Jiangxi is 49.63 %, which are approximate 100 % and 50 % respectively, and in order to better distinguish the types of endowments, this article has adjusted the criteria. The new criteria are given below:

When 60 % $\leq$ SR $\leq$ 120 %, the area is basically self-sufficient area;
When 40 % $\leq$ SR $\leq$ 60 %, the area is half self-sufficient area;
When SR < 40 %, the area is called net recharge area;
When SR > 120 %, the area is called net disbursement area.

According to the new criteria, the energy resource endowment of 29 provinces and autonomous regions can be classified again. The results are shown in Table 27.2.

Table 27.1 Energy consumption of each province and autonomous region from 1995 to 2009

	1995	2009		1995	2009
Beijing	24.82	100.00	Henan	139.87	132.85
Tianjin	44.5	24.32	Hubei	31.51	139.87
Hebei	81.36	44.5	Hunan	80.81	31.51
Shanxi	302.32	81.36	Guangdong	36.96	80.81
Inner Mongolia	204.45	302.32	Guangxi	53.10	36.96
Liaoning	74	204.45	Hainan	13.09	53.1
Jilin	66.93	74	Sichuan	89.16	13.09
Heilongjiang	243.69	66.93	Guizhou	131.73	89.16
Shanghai	11.1	243.69	Yunnan	87.84	131.73
Jiangsu	36.06	11.1	Shaanxi	113.79	87.84
Zhejiang	12.72	36.06	Gansu	89.49	113.79
Anhui	84.78	12.72	Qinghai	66.06	89.49
Fujian	49.63	84.78	Ningxia	165.06	66.06
Jiangxi	95.02	49.63	Xinjiang	144.49	165.06
Shandong	132.85	95.02			

Table 27.2 Classification of energy endowment area (1995 and 2009)

	1995 (year)	2009 (year)
Net disbursement area	Shanxi, Inner Magnolia, Heilongjiang, Shandong, Henan, Guizhou, Ningxia, Xinjiang	Shanxi, Inner Magnolia, Heilongjiang, Anhui, Guizhou, Shaanxi, Ningxia, Xinjiang
Basically self-sufficient area	Hebei, Liaoning, Jilin, Anhui, jiangxi, Hunan, Sichuan, Yunnan, shaanxi, Gansu, Qinghai	Tianjin, Jilin, Henan, Yunnan, Gansu, Qinghai
Half self-sufficient area	Tianjin, Fujian, Guangxi	Hebei, Liaoning, Fujian, jiangxi, Shandong, Hunan, Sichuan
Net recharge area	Beijing, Shanghai, Jiangsu, Zhejiang, Hubei, Guangdong, Hainan	Beijing, Shanghai, Jiangsu, Zhejiang, Hubei, Guangdong, Guangdong, Guangxi, Hainan

From Table 27.2, it can be known that the pattern of energy endowment in 2009 is significantly different from the pattern of energy endowment in 1995. The numbers of provinces in the four kinds of energy endowment areas are changed, except the number of provinces in net disbursement area in 2009 and 1995. The number of provinces in basically self-sufficient area is almost reduced by half, from 11 to 6. The number of provinces in half self-sufficient area increased from 3 to 7, more than doubled. The number of provinces in net recharge area increased from 7 to 8. A great change happened in basically self-sufficient area. Jilin, Yunnan, Qinghai and Gansu were still in this area, while Hebei, Liaoning, Jiangxi, Hunan and Sichuan all get into half self-sufficient area. And Tianjin, which belonged to half self-sufficient area in 1995, becomes a new member of basically self-sufficient area in 2009. In half self-sufficient area, only Fujian still kept inside.

Beijing, Shanghai, Jiangsu, Zhejiang, Hubei, Guangdong, and Hainan were still in net recharge area. And Guangxi, which in half self-sufficient area in 1995, also get into net recharge area in 2009. According to the above analysis, it can be seen that there are big changes in basically self-sufficient area and half self-sufficient area; however, the change in net recharge area is most difficult. There is no province in net recharge area changed into other energy endowment area.

27.2.2.4 Industrial Added Value

Because the energy production and consumption are most closely related to industry in secondary industry, when discuss the relationship between energy resource endowment and industrial structure, the relationship between energy resource endowment and industry are focused on (Wang 2010) (Table 27.3).

Take 1995 as the base period, industrial added value divided by consumer price index (CPI) will be the industrial added value which has taken out of inflation. Industrial added value of each province and autonomous region all increased to some extend from 1995 to 2009. From the absolute amount of industrial added value, Guangdong, Shandong, Jiangsu, Zhejiang, Henan, Sichuan, Hebei, Liaoning and Shanghai have the highest industrial added value in both 1995 and 2009, and Xinjiang, Guizhou, Gansu, Ningxia, Qinghai, Hainan and Tibet have the lowest one. And the industrial added value of the other provinces and autonomous regions all increased in different degree. In terms of the growth rate of the industrial added

Table 27.3 Industrial added value and growth of each province and autonomous region from 1995 to 2009

Region	LAV in 1995	IAV in 2009	Growth	Order	Region	IAV in 1995	IAV in 2009	Growth	Order
China	249.51	1034.23	3.15		Henan	12.57	75.71	5.03	9
Beijing	5.28	17.61	2.34	27	Hubei	6.81	39.64	4.82	11
Tianjin	4.68	27.7	4.92	10	Hunan	6.59	36.86	4.60	14
Hebei	11.50	61.06	4.31	18	Guangdong	24.49	138.3 5	4.65	12
Shanxi	4.39	26.91	5.14	8	Guangxi	4.61	21.9	3.75	23
Inner Magalia	2.55	34.44	12.51	1	Hainan	0.44	2.3	4.22	19
Liaoning	12.33	52.96	3.29	25	Sichuan	11.93	65.73	4.51	16
Jilin	4.14	23.36	4.64	13	Guizhou	2.09	9.58	3.59	24
Heilongjiang	9.49	27.15	1.86	30	Yunnan	4.81	15.97	2.32	28
Shanghai	13.08	41.36	2.16	29	Tibet	0.04	0.25	5.18	6
Jiangsu	24.68	125.91	4.1	21	Shaanxi	3.78	26.78	6.09	3
Zhejiang	16.46	80.44	3.89	22	Gansu	2.26	9.21	3.07	26
Anhui	5.62	31.08	4.53	15	Qinghai	0.52	3.6	5.97	4
Fujian	7.49	39.05	4.21	20	Ningxia	0.63	3.98	5.28	5
Jiangxi	3.14	24.45	6.77	2	Xinjiang	2.19	11.9	4.43	17
Shandong	20.98	129.21	5.16	7					

Table 27.4 The proportion of the industrial added value accounted for the GDP of each province and autonomous region in 1995 and 2009

Region	1995 (year)	2009 (year)	Increase/ reduce	Region	1995 (year)	2009 (year)	Increase/ reduce
Beijing	35.055	18.951	−16.054	Hubei	32.281	39.994	7.714
Tianjin	50.209	48.155	−2.054	Hunan	30.893	36.903	6.01
Hebei	40.375	46.322	5.947	Guangdong	41.274	45.822	4.547
Shanxi	40.752	47.822	7.07	Guangxi	30.8	36.909	6.109
Inner Magalia	29.739	46.234	16.495	Hainan	12.124	18.174	6.05
Liaoning	44.154	45.526	1.372	Chongqing	35.404	44.677	9.273
Jilin	36.391	41.966	5.575	Sichuan	34.101	40.125	6.024
Heilongjiang	47.66	41.338	−6.322	Guizhou	32.811	32.016	−0.796
Shanghai	52.34	35.947	−16.393	Yunnan	39.353	33.845	−5.507
Jiangsu	47.866	47.784	−0.083	Tibet	7.307	7.502	0.195
Zhejiang	46.254	45.751	−0.503	Shaanxi	36.448	42.856	6.408
Anhui	31.063	40.393	9.331	Gansu	40.571	35.533	−5.038
Fujian	35.75	41.731	5.981	Qinghai	30.763	43.498	12.735
Jiangxi	26.886	41.757	14.871	Ningxia	36.172	38.452	2.28
Shandong	42.356	49.846	7.49	Xinjiang	26.877	36.376	9.499
Henan	42.047	50.822	8.775				

value, Inner Magalia, with the highest growth rate of 12.51 %, followed by Jiangxi, Shaanxi and Qinghai. However, Heilongjiang, Shanghai, Yunnan and Beijing have the lowest growth rate, which are less than 3 %. By contrast with the whole country's industrial added value, only Gansu, Beijing, Yunnan, Shanghai and Heilongjiang's growth rate of the industrial added value are below the national level, and other provinces and autonomous regions are above the national average level.

From Table 27.4, it can be seen that most provinces and autonomous regions' proportion of the industrial added value accounted for the GDP increased from 1995 to 2009, except Beijing, Tianjin, Heilongjiang, Shanghai, Jiangsu, Zhejiang, Guizhou, Yunnan, Gansu and so on. In the case of the absolute value, in 1995, the proportion of the industrial added value in GDP in Shanghai, Tianjin, Jiangsu, Heilongjiang, Zhejiang, Liaoning, Shandong, Henan and Guangdong all are over 40 %; however, this proportion in Tibet, Hainan, Xinjiang, Jiangxi and Inner Magalia are below 30 %. But there is a vast difference between the situation of the proportion in 2009 and 1995. In 2009, the highest proportion of the industrial added value accounted for the GDP belongs to Henan, Shandong, Tianjin, Shanxi, Jiangsu, Hebei, Inner Magalia and Guangdong is highest, and the lowest one belongs to Tibet, Hainan, Beijing, Guizhou, and Yunnan. But the proportion of all provinces and autonomous regions all increased greatly. There are 8 provinces with the proportion over 40 %. In the case of growth range, Inner Magalia has the largest range of growth, which is 16.5 %, followed by Jiangxi and Qinghai, whose growth range are 14.9 % and 12.7 % respectively. The proportion of Shanghai and Beijing decreased by 16.4 % and 16.1 % respectively; the proportion of Heilongjiang, Yunnan, Gansu, also decreased.

27.3 Empirical Analysis

27.3.1 Econometric Model and Data Analysis

Considering the availability of data, this article has chosen 15 years' panel data (from 1995 to 2009) of 30 provinces and autonomous regions except Tibet, Hong Kong, Macao and Taiwan, as the basis for constructing model. And in order to make the calculation more convenient, this article will put Chongqing's energy production and consumption into Sichuan. Therefore, 15 years' panel data of 29 provinces and autonomous regions are included in the analysis. In addition, according to the previous study, it can be known that the GDP of industry accounted for the vast majority of the GDP of the secondary industry, and the trends of change with time are relatively consistent, so this article regards the proportion of industrial added value accounted for the GDP as the substitution variable of industrial structure, simultaneously regards energy self-sufficiency rate as the substitution variable of energy resource endowment (Jiang and Wu 2010). There are two reasons why Panel Vector Autoregressive Model (PVAR) is used to analyze and estimate. Firstly, data of 29 provinces and autonomous regions are included in the analysis, if construct VAR model respectively, 29 VAR systems need to be founded, that's too tedious. The second and most important reason is that annual data are used in this article, while each province's sample sizes can't reach VAR model's requirements; however, in contrast with VAR model, PVAR model greatly reduces the requirement to the length of time series. If T represents time length, and m represents order of the lagged variable, so when $T \geq m + 3$, parameters could be estimated; when $T \geq 2m + 2$, parameters of the lagged variable at steady stage could be estimated. As mentioned above, PVAR Model will be used to estimate the proportion of the energy self-sufficiency rate and industrial added value accounted for the GDP.

Love and Zicchino (2006) researchers of World Bank, used PVAR in "Financial Development and Dynamic Investment Behavior: Evidence from Panel VAR", and successfully carried out estimations in STATA. This article will take Inessa Love's method as reference, and do researches on the mutual relationship of each province's energy resource endowment and industrial structure (Love and Zicchino 2006).

Before utilizing PVAR Model, the data's stationarity should be tested (Jiang and Ji 2011). Schwarz Standard is used to select lag phase, and Eviews6.0 put into use. It can be seen that the proportion of the industrial added value accounted for the GDP and energy self-sufficiency rate all failed to pass the test of stationarity;

therefore a differencing would be carried out. After differencing, self-sufficiency rate can be expresses in annual growth speed (DFEUL), and the proportion of the industrial added value accounted for the GDP can be expresses in the annul growth range of the proportion (DIND).

The stationarity tests of DFEUL and DIND are given below:

	Test form	Test statistics	P value	Result
DFEUL	(C, 0, 1)	−19.6832	0.0000	Stable
DIND	(0, 0, 2)	−9.46134	0.0000	Stable

According to the results of stationarity tests, it can be known P values have passed the test, and after a differencing, self-sufficiency rate and the proportion of the industrial added value accounted for the GDP are stable.

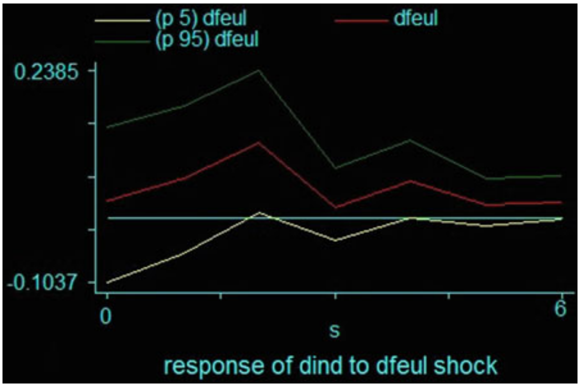
After test of stationarity, the lag period of 2 is chosen; therefore the following PVAR Model could be constructed.

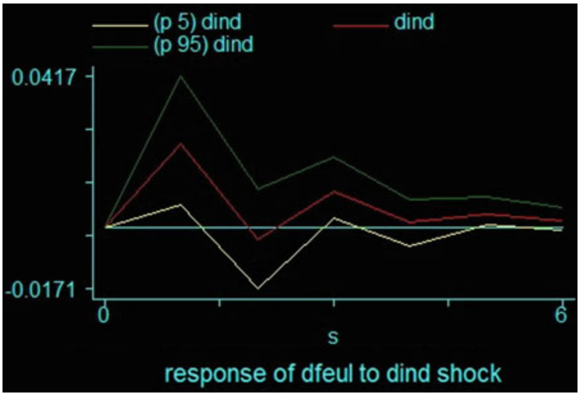
$$y_{it} = \alpha_i + \gamma_t + Ay_{it-1} + y_{it-2} + \varepsilon_{it}$$

In the above formula, y_{it} = [$DFEUL_{it}$, $DIND_{it}$]'; α_i is the entity effect vector of 2*1; and γ_t is the time effect vector of 2*1.

27.3.2 Panel VAR Model of Industrial Structure and Energy Self-Sufficiency Rate

In STATA11, program written by Inessa Love would be used to analyze PVAR Model. Impulse response figure is given below:





According to the impulse response relationship between the growth speed of energy self-sufficiency rate and the growth range of the proportion of the industrial added value accounted for the GDP, it can be seen that under 5 % of confidence level, the change of the growth speed of energy self-sufficiency rate could positively influence on the growth range of the proportion of the industrial added value in GDP, and this positive influence would reach a maximum in the fourth period, and then gradually reduce, the minimum influence would appear in the sixth period. After that, this kind of influence is fluctuating then trend to be stable, and close to zero in the tenth period. Therefore, when the growth speed of energy self-sufficiency rate is larger than last year, its influence on the proportion of the industrial added value accounted for the GDP will be greatest in the fourth year. In the fourth year, when the growth speed of energy self-sufficiency rate increased by 1 %, the proportion of the industrial added value to the GDP will increased by about 0.12 %. After that, the influence of the growth speed of energy self-sufficiency rate on the proportion of the industrial added value accounted for the GDP will gradually reduce. Therefore, it can prove that energy resource endowment could affect industrial structure, this influence is notable but with a lag. Usually, the influence of the change of energy endowment on industrial structure will reach a maximum in the fourth year, and the rate of change should be faster and faster otherwise could not positively affect industrial structure.

Moreover, from the above figure, it can be seen that the growth range of the change of the proportion of the industrial added value accounted for the GDP also positively influence on the change of the growth speed of energy self-sufficiency rate at the beginning, and reach the maximum in the second period. And then this influence will be gradually reducing until become negative in the fourth period. After that, this influence will increase again and close to zero in the fluctuation, then infinitely close to zero in the eighth period. That is, the growth range of the proportion of the industrial added value accounted for the GDP has positive and significant influence on the growth rate of energy self-sufficiency rate. When the proportion of the industrial added value accounted for the GDP increased by 1 %, the growth speed of energy self-sufficiency rate will be increased by about 0.023 %, and the greatest impact appears in the second year. Therefore, it can prove that the change of industrial structure could affect the change of energy resource endowment. This influence is stable and notable, and the greatest impact would appear in the second year.

27.3.3 Results

Through the entity fixed effects model and time fixed effects model of the proportion of the energy self-sufficiency rate and industrial added value accounted for the GDP, some results could be get. The results are given below:

From the impulse analysis of the proportion of industrial added value accounted for the GDP and the impulse analysis of energy self-sufficiency rate, there is definitely a stable and notable relationship between industrial structure and energy resource endowment. That means energy resource endowment could influence on industrial structure at some extent, and industrial structure also could affect energy structure, but the mutual influences of both parties all have time lag. The growth speed of energy self-sufficiency rate could positively influence on industrial structure. If the growth of energy endowment is accelerated, the proportion of industry to industrial structure would be increased more. Similarly, if the growth of energy endowment is slowed down, the proportion of industry to industrial structure would be increased quite slowly, and even would be decreased. However, energy endowment has longer time lag in the influence on industrial structure. The influence of energy endowment's impulse on the change of industrial structure would reach a maximum in the fourth year, and then gradually decline until no significant impact.

The proportion of the industrial added value accounted for the GDP also has positive impulse influence on energy self-sufficiency rate, which means the change of this proportion's growth range is the same as the direction of the change of energy endowment's growth speed. Therefore, industrial structure's change also positively influence on energy endowment. The greater the change of industrial structure, the faster the speed of energy endowment's change. In the same way, there is a time lag in the influence of energy endowment on industrial structure, but this time lag is comparatively shorter, only 2 years. That is, the greatest influence of industrial structure on energy endowment will appear after 2 years, and then gradually decline until no significant impact.

According to the impulse coefficient of the proportion of the energy self-sufficiency rate and industrial added value accounted for the GDP, it can be seen that the impulse coefficient of the proportion of the energy self-sufficiency rate accounted for the GDP to the proportion of the industrial added value accounted for the GDP is larger than the proportion of the industrial added value accounted for the GDP to the proportion of the energy self-sufficiency rate accounted for the GDP. Therefore, it can be proved that comparatively, the change of industrial structure depend more on energy endowment, but depend less on other factors outside energy and has smaller carryover effects; however, the change of energy endowment depend more on the change of industrial structure, but depend less on other factors outside industrial structure and has comparatively smaller carryover effects.

27.4 Political Suggestions

Local governments should focus on improving the efficiency of using energy, and encouraging the development of new energy technology and new energy-saving technologies. The governments also need to actively guide enterprises and research institutions to carry out technical innovation through preferential policies and intensify financial support for technical innovation and technical industrialization, so as to improve China's ability of originality innovation. In the spirit of innovation, localization of new technology could be realized through introduction, digestion and absorption of foreign advanced technology. To be sustainable developing, it is advisable to promote the application of new energy and energy-saving technology, reduce the dependence of industrial development on traditional exhausted resources, and achieve harmony and unity of industrial development and utilization of new energies.

It is wise to speed up the developmental process of service industry, improve the service industry system and achieve reasonable layout of three industries. Industry consumes most energy, while service industry relatively less dependent on energy. Through the adjustment of industrial structure, the dependence of economic development on energy could be reduced. What the governments and enterprises need to do are improving energy utilization efficiency, realizing green economic growth; developing high value-added modern industrial system, promoting production technology of industry; and actively improving the service industry system, achieving reasonable layout of three industries.

In addition, the provinces in different energy endowment areas should strengthen communication and cooperation so as to get the mutual profit. Eastern, central and western regions are in different stages of industrial development and transfer, so in the future development communication and cooperation of different energy endowment areas should be explored, long term stable coordination mechanism should be founded. Moreover, provinces in different energy endowment area should build a relationship of joint training, exchange and cooperation in the fields of raw materials, energy, talent, technology, etc. Through this long-term mechanism, the distribution of resources could be optimized, and win–win situation would be achieved. By communicating with different provinces, the formulating of industrial policies would be more scientific reasonable, so that the trend of industry structure similarity would be avoided, local protectionism would be eliminated, fair competition in the market of different provinces would be realized, complementary industry pattern would be shaped.

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Chapter 28
Strategic Choices of Development of China International Education in the Early Twenty-First Century

Jia-fu Cheng, Shu-fang Hou and Song-lin Chen

Abstract The career of China International Education, which is closely related to China's politics, diplomacy, culture, education, economy and other interests, should be developed better and faster for a long time. Since the beginning of this century, China international education has entered a period of rapid growth, but still there are some security risks such as unknown targets, structural imbalance and poor quality, so it is in urgent need of strategic planning. By the SWOT analysis on the aspects of advantages and disadvantages, opportunities and challenges of China International Education, this article puts forward some strategic countermeasures including to build a cultural power as the goal, to enhance the quality of teaching as the cornerstone, to grasp Chinese language teaching as a leader, and to focus on the students resource from neighboring countries.

Keywords Advantages · Challenges · China international education · Disadvantages · Opportunities · Strategic countermeasures

28.1 Introduction

The cause of China International Education is closely related to the interests of China's politics, diplomacy, culture, education, economy and others, which should be developed better and faster for a long time. Over the past decade, China

J. Cheng (✉) · S. Hou · S. Chen
School of Law and Politics, Anhui Institute of Architecture and Industry,
Hefei, Anhui, China
e-mail: eric998@163.com

S. Hou
e-mail: houshufa5570@qq.com

S. Chen
e-mail: songlin0001@163.com

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International Education has maintained a momentum of rapid development, but there are still some outstanding issues including ambiguous goal, structural imbalance and poor quality, which is in great need for strategic planning. By the SWOT analysis in strategic management (also known as trend analysis), this paper analyses comprehensively four aspects of China International Education involving its strengths, weaknesses, opportunities and threats, and then proposes some strategic suggestions to develop China International Education in this new century.

28.2 Strengths of China International Education

28.2.1 Rapid Development of China's Economy

Since the beginning of this century, China's economy has been in the high-speed development. From 2000 to 2010, annual average growth rate of China GDP is more than 10.3 %, which ranked second in the world in 2010. China's per capita GDP reached $5,500 in 2011 (Xinhua Daily 2011).

This "economic miracle", not only enhances China's comprehensive national strength and international image, lays the material basis for the development of higher education, creates a huge potential job market, but also results in a more attractive for international students, especially the neighboring countries'. From 2000 to 2011, China foreign students increased to 292,611 (in 2011) by 52,150 people (in 2000), with an increase of 240,000 people, 5.6 times more than in 2000, the annual net increase of 22,000 people, the annual average growth rate of 17.8 %, far higher than the average growth rate of international students (9 %).

28.2.2 Be Improving of the Policies of Study in China

At present, a set of open policies for China international students have basically formed. Before the reform and opening up, the policies are relatively closed, only accepting scholarship students of the socialist countries and Asia, Africa and Latin America and other friendly countries. Because the scholarships provided by China government were limited, the international students in this period were less than 500 per year (except 1965). After the reform and opening up, the policies are becoming more opening, gradually opened up a self-financed student channel, with the main policies including "On the instructions of accepting foreign students at their own expense rate" (1979); "Management approaches to foreign student" (1985), "The relevant provisions for recruiting self-funded foreign students" (1989); "The management regulations for China government scholarships" (2008). These policies entitled colleges and universities with the rights of enrollment, teaching and management, which greatly stimulated the school's enthusiasm and initiative. In addition, in recent years, China government has increased funding efforts for international students, in 2011, the government scholarships were increased to 25,687 people, accounting for 8.8 % of China total number of students. Under the guidance of the above policies, China international students averagely increased to 5,000 people per year in the 1990s, and an annual increase of 23,000 after the year of 2000, significantly accelerating the growth rate over the previous period.

28.2.3 Comparative Advantages of China Higher Education's Quality

After seven years expansion of China higher education scale, it amounted to more than 23 million students in 2005, ranking first in the world. In this process, it also brought the tension between educational quantity and its quality. However, in 2006, China decided to control properly the growth rate of enrollment so as to ensure the focus on improving the quality. This marks the conversion of main development mode from scale expansion to quality improving of higher education. In recent years, compared with the developing countries, China higher education has some comparative advantages, gradually was recognized by the international community, and received more and more international students. By 2008, China has signed some mutual recognitions of academic degrees agreement with 34 countries and regions including Germany, Britain, France, Australia, Russia and other developed countries, and it no doubt played a significant role in promoting to attract the students of these countries.

28.3 Weaknesses of China International Education

28.3.1 Lower Strategic Positioning of Developing China International Education

Strategic positioning is the foundation of strategic planning as well as the guide of formulation of concrete plans. For the current strategic positioning of the international education, China government has made such provisions: "To promote understanding and friendship between China and the peoples of the world, promote international exchange and cooperation in Higher School[1]"; "To enhance international educational exchange and cooperation, improve international educational level in China (Ministry of Education of China 2010)". Obviously, China only wishes to play two functions of international education in education and diplomacy. In fact, the Overseas Education also has other functions such as politics,

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[1] China Scholarship Council, regulations for colleges and universities accepting foreign students. http://www.csc.edu.cn/Laihua/4c75fc325129413f985a5a285ec661ec.shtml. (In Chinese)

cultural, economics, attracting talents and so on. Therefore, the lower strategic positioning of international education is not suitable for international and domestic situations, nor conducive to enhance both the international influence of national cultural and soft power of Chinese culture.

28.3.2 Poor Teaching Quality

In recent 10 years, the scale of China international students has mounted up rapidly, and the education management has become increasingly standardized, but the quality of teaching is worrying. The survey shows that the foreign students who are "Very dissatisfied" and "dissatisfied" account for 25 % of the total, "normal" for 42.8 %, "very satisfied" and "satisfied" only for 32.3 % (Xiao-jiong 2010). However, the international students' satisfaction with the quality of teaching in developed countries is much higher than in China. England made a survey which showed that the satisfaction of the foreign students with the quality of the course amounted to nearly 90 % in 2004 and 2006 (UKCOSA 2010). And another one in Australian 2008 showed that students' satisfaction with the course amounted to 81 % (Australian Education International 2007). When choosing a study destination abroad, international students consider its teaching quality first. The survey on 879 students in Australian universities in 2002 found that the quality of teaching is the most important factor which influences their selecting institutions (Russell 2005). A similar survey in the United Kingdom revealed that there are 44 % of the total students who regard the university's international reputation as the primary factor of choosing their study destinations (Anonymous 2009). Nowadays, colleges and universities in China open fewer public courses, fewer international courses and professionals, coupled with the poor quality of teaching, and this situation is bound to affect the sustainable development of China international education.

28.3.3 Low Levels of China International Education

"At present, the foreign education in developed countries has grown to the stage characterized with postgraduates, supplemented by undergraduates and advanced students" (Wang 2006). In the school year of 2009–2010, the number of foreign students in the United States was 647,000, of which graduate students accounted for 42.4 %, undergraduate students for 34 % (Open Doors Data International Students: Academic Leve 2009). And the number in the United Kingdom (in 2004) was 318, 000, of which graduate students accounted for 52.1 %, undergraduate students for 38.8 %, others for 9.1 % (Fu-zeng 2009). Whereas, in China, the number of foreign students in 2011 was 293,000, of which graduate students only accounted for 10.4 % of the total, college students for 30.2 %, the others nearly for

60 % were non-degree students (Ministry of Education of China 2011). Therefore, from the viewpoint of education level, the current education of study in China has still been in the early stages of the main non-academic education.

28.4 Opptunities of China International Education

28.4.1 Needs of Overseas Education in Rapid Growth

In the context of world economic integration, products, capital and personnel in the world can freely flow, which contains the international mobility of students. The economic integration has expanded the demand for international talents, and study abroad is an important way to cultivate such talents. Countries around the world are shorter of international talents, which gave birth to the huge demand for overseas education, triggering the arrival of the international study abroad. Since 2000, the scale of international students has been accelerating. During the past 5 years (2000–2005), it increased to 600,000 people; during the past three years (2005–2008), it increased to 700, 000. From the viewpoint of net increase of average annual, it was 163,000 people from 2000 to 2008; only 70,000 people from 1990 to 2000.

There are three categories of flows of international students: First, Flowing from developing to developed countries. Such as the students in Asia, Africa and Latin America and other developing countries, flow to Europe and the United States and other developed countries. Secondly, flowing from some developed countries to the other developed countries. Such as the students in North America, Western Europe flow between the countries. Thirdly, moiling between countries in the same region, such as the student's mobility between countries within the EU, NAFTA and other regional organizations. By comparison, under the promotion of regional economic integration in recent years, international students tend to flow within the region. In the next several years, the students from Asia and other neighboring countries will continue to be mainly China foreign students, with the reason that China has closer exchanges in politics, economics, and culture among the countries.

28.4.2 Further Broadening the Channels for International Student Mobility

From 1950s to 1980s, under the polarization pattern enveloped the entire world dominated by the United States and Soviet Union, the countries between the socialist camp and the capitalist camp have less exchanges in politics, economics, culture and education. And there're more political obstacles for mutual exchange students, which limits the expansion of the scale of students to some extent. In the early 1990s, with the collapse of the Soviet Union and Eastern Europe, the long-term "Cold War" situation was ended, and the international relations in general were gradually moderated. After the 1990s, the countries all over the world have given much attach to their economic development, actively develop multilateral relations in politics, diplomacy, economics and trade, try to create a relatively harmonious foreign exchange atmosphere. In particular, more and more developed countries in the world such as the United States, Britain, France, Australia and Japan, etc., have regarded the cause of foreign education as one of the basic national policy, and this plays a significant role in promoting on international student mobility and scale of the expansion.

28.4.3 Expanding Capacity of International Students

Higher education is the parent body of the international education for its growing and developing. From the viewpoint of the relationship between the growth scale of higher education and the number of foreign students, from 1980 to 2004, accompanied by the amount of the world's universities students expanding, the number of international students is growing faster, and the proportion of international students who accounted for the students in colleges and universities is also gradually increasing. Especially after 1990, the three above grew faster (Table 28.1). This phenomenon shows that there's an overall positive correlation between the growth conditions of international students and the developmental scale of higher education in the world. This gives us a lesson: there will be likely to attract more foreign students, with the expansion of China higher education, and as well as the increasing of its enrollment rates.

28.5 Threats to China International Education

28.5.1 Increasingly Competing in the International Education Market

At present, the major share of the international education market in the world is occupied by developed countries. In 2008, the international students soared to $3.3 million. Among those, the foreign students in the United States (18.7 %), the

Table 28.1 Proportion of international students occypied world university students (Unit: million)

Years	Students in the school	Foreign students	Foreign students accounting for the total students(%)
1980	5116.1	89.5	1.75
1990	6866.5	123.6	*1.80*
2000	9867.0	187.9	1.90
2004	13142.3	247.8	1.89

Data source UNESCO. http://www.unesco.org

United Kingdom (10.0 %), Australia (6.9 %) and Canada (5.5 %) accounted for 41.1 % of the total global, while the students from developing countries including Russia (4.3 %), China (2.4 %) accounted for less than 5 %. In the top ten countries, there're eight developed countries, of which together accounted for 61.5 % of the total (Table 28.2). Obviously, developed countries have a significant competitive advantage in the international education market.

In the international education market, China faces severe competitive situation. On the one hand, in order to accept more students, China has to compete with powerful educational countries such as the United States, Britain, and Australia. On the other hand, to compete with many neighboring developing countries and regions such as Singapore, Malaysia, India and Hong Kong. In addition, the surrounding countries are actively trying to develop their domestic higher education, to some extent, which will reduce their demand for domestic students to study abroad. Therefore, China international education market has been squeezed by many factors.

28.5.2 Chinese International Versatility is Not Wide

Compared with English language, Chinese is not as universal and widely used as English. A survey showed that the language used by the world internet in English accounted for 85 % of the total; the e-mail in English accounted for 78 %; the language used in the United Nations on various occasions in English accounted for 95 %, and Chinese utilization only for a few tenths percent (Ding-ou 2008). English is the most powerful, widely available language in the world, which has become the first foreign language of over 100 non-English speaking countries. Before studying abroad, the majority of international students have learned English for several years. However, among the China international students, over 90 % of the total had not learned Chinese, which caused great pressure on them for successfully completing their education. Therefore, it has become a major bottleneck for developing China international education that international promotion of Chinese is not so wide.

28.5.3 Relatively Scarce with Educational Resources in China

In 2003, the scale of higher education in China has surpassed the United States, ranking first in the world. According to the principle of economies of scale, the greater the scale of one country's higher education, the more the absolute number

Table 28.2 Proportions of international students at the top ten counties in the world (2008)

S/n	1	2	3	4	5	6	7	8	9	10
Country	USA	UK	Germany	France	Australia	Canada	Russia	Japan	China	Italian
(%) of Tot.	18.7	10.0	7.31	7.3	6.9	5.5	4.3	3.8	2.4	2.0

Data source OECD. Education at a glance, 2010, pp. 312

of foreign students can be accepted. However, if the higher education resources in the country are serious shortage, it is difficult to accommodate large numbers of foreign students. Only when the resources are slightly larger than or equal to the demand for the supply of higher education, the advantages of economies of scale can play a role, and the country can have the comparative advantage of the larger export education (Qu 2004). Nowadays, higher education resources in China are still insufficient supply, especially, shorter of high-quality educational resources. In 2010, higher education gross enrollment rate in China was 26.5 % (People's Daily 2011), which greatly restricted the strengths and capabilities of China's higher education exports. Compared with developed countries in the world, in 2007, higher education gross enrollment rate in Australia (86 %), United States (65 %), Britain (55 %) and Japan (46 %) (OECD 2010), is much higher than China, and most of the countries' are more than 50 %. This indicates that the internal educational resources of these countries are relatively abundant, and even affluent, so they have formed the actual needs and conditions for the export of higher education.

28.6 Strategic Choices to Develop China International Education

28.6.1 To Build a Cultural Power as the Developmental Goal

Currently, the overall quality of foreign students is poor; the teaching form is mainly taken by training alone; the students learning Chinese language and literature students accounted for over 60 % of the total. All of the characteristics indicate China international education is still at an early developmental stage. In this context, China can not apply the talent pool strategy like the USA, which hunts international talents through development of overseas education; nor can learn from the United Kingdom and Australia, which use the educational industrialization strategy to obtain the substantial economic benefits; but China should learn from Germany, France and Japan, which apply the cultural and international promotion strategy, which is gradually expanding the influence and competitiveness of Chinese culture in the world, and serving the strategic objective of building a culture of power.

28.6.2 To Improve the Teaching Quality as the Cornerstone

The quality is the lifeline of China international education. For improving it, the brand strategy of China education can be applied. In particular, the following work should be focused on: First, at the enrollment links, we should take a flexible enrollment pattern, lay downa unified admission standards and entry requirements for foreign students, to ensure that foreign students achieve the quality of necessary language requirements and professional standards. Secondly, in the training links, we can use the assimilation of teaching management for Chinese and foreign students, which requires both Chinese and foreign students use the unified training program in the same profession, and the same standard of academic achievement should be reached. Thirdly, in the faculty building, we should enhance teachers' proficiency training in foreign language teaching, improve the teachers' performance evaluation methods for China international education, and train as soon as possible a group of outstanding teachers with higher academic skills, proficiency in teaching and caring students.

28.6.3 To Grasp Chinese Language Teaching as a Leader

It is the main purpose of China international students to learn. A survey showed that 85.4 % of the total students pointed out that learning Chinese was an important or very important factor when they chose to study in China. Since 2000, the size of students to learn Chinese language has been the largest, which has accounted for more than 60 % of the total. Therefore, in order to expand quickly the size of foreign students, and improve the students' satisfaction, we should try to study the theory and practice of Chinese Language, to improve effectively the training quality of Chinese language.

In addition to Chinese Language, we should play actively the comparative advantages of other professions and disciplines. First, focusing on the professions characterized with Chinese culture such as literature, art, traditional Chinese medicine, sports, and so on. Secondly, striving to expand the professions' scale related with international economic and trade such as economics, management and law. Finally, expanding steadily the students' scale of science and engineering by improving the education quality.

28.6.4 Focusing on the Students Source from Neighboring Countries

Since this century, the amount of China international students from neighboring countries has accounted for about 80 % of the total, among which the students from developing countries has accounted for more than 60 %. According to the UNSCO statistics, international students all over the world in 2006 amounted to 2.29 million, among which the students come from East Asia, Southeast Asia and South Asia has reached to 85 % of the total. A prediction from Australia in 2025 that international students will grow to 7.2 million, among which 70 % will come from Asia (Fu-zeng 2009). In addition, the Chinese and overseas Chinese in East

Asia, Southeast Asia, are currently more than 10 million, which accounts for more than 80 % of the total of Chinese around the world. As the ASEAN-China relations are continuing to improve, there will be a large number of foreign students coming to China for study. Therefore, China should look on neighboring countries as the key areas for expansion of the students scale.

28.7 Conclusion

In a word, when designing the strategy of the China international education, we should pay close attention to our own characteristics and advantages, learn from the successful experiences of other countries, and try to build such a kind of educational system characterized with the combination of academic and non-degree education, varied categories, and the balance of professions and students resource. Specifically, under the condition without affecting the educational quality of domestic students, we should expand actively and steadily the scale of China international education, by constructing the strategy of cultural power for the lead, enhancing the quality of teaching as the cornerstone, focusing on the students resource from neighboring countries.

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Chapter 29
Supervisory Game Between Sci-Tech Bank and VC Firm

Xing-guo Gong and Yu-hong Chen

Abstract Facing the bottleneck phenomenon of small and medium-sized enterprises (SMEs) that they are difficult to get the loan and guarantee, Science and Technology (Sci-Tech) bank offers bank debt and equity combination model to support SMEs, to some extent easing the financing difficulties. But technological innovation of SME is a multistage process. Due to the existence of regulatory costs after the initial investment, it will bring the competing relationship changes among the initial investors. Through the limited cooperation game, this paper studies the relationship between Sci-Tech bank and Venture Capital (VC) firm. The result shows Sci-Tech bank should choose the cooperation with VC firm, for ensuring the fund supply.

Keywords Cooperation game · Sci-tech bank · SME · VC firm

29.1 Introduction

In recent years, the financing of SME has been greatly concerned. VC firm is the major funding source of SMEs, and the development technological innovation of SMEs promotes venture capital market competition. In 2009, Silicon Valley Bank

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X. Gong (✉) · Y. Chen
Department of Economics and Management, Yanshan University,
Qinhuangdao, China
e-mail: guoxg@ysu.edu.cn

Y. Chen
e-mail: winterbly@163.com

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(SVB) established a representative office in Shanghai, which spurred Sci-Tech bank of China to join the venture capital market. Based on the traditional loan model, that is bank-SME-guarantee company model, the Sci-Tech bank new type load model develops. It brings the introduction of venture capital industry, to explore the solutions to the financing problem of SME. Compared with traditional state-owned bank, Silicon Valley's Sci-Tech bank broke the restrictions of the bond-type investment and equity investment and connected the credit market and capital market. What the most important is that its customers must be supported by VC firm, primarily based on the asset-backed credit, with customers signing the technological patents as collateral. In foreign countries, like SVB, Sci-Tech bank and VC firm's activities can be described as going hand in hand, whereas in China, with the changing of interest after the initial finance, what the relationship between the two is this paper mainly talking about.

The remainder of the paper is organized as follows. The next section briefly reviews the financial sources in innovation of SMEs and puts forward the conception of Sci-Tech bank. Part three builds a regulatory game model, and explains the relationship between Sci-Tech bank and VC firm under different circumstances after the initial finance. The last part reports the results, and proposes a few favorable suggestions about how Sci-Tech bank develops to support SMEs better.

29.2 Theoretical and Related Literature

The analysis in this article focuses on the influence of Sci-Tech bank, which is one of the financial sources in the innovation activity of SMEs. Because Sci-Tech bank is a newborn, previous literature mainly focused on the financial structure, and this direction causality had so far found limited attention.

29.2.1 Factors of Financing

For SMEs, their financial structure is influenced by many factors; it is not simple to say whether inside or outside sources are preference. John et al. (2002) investigate the financial characteristic of new small firms, the results suggest that the share of long-term debt to total assets is negatively related to investments in knowledge, but the relationships between knowledge-intensity and capital structure are bi-directional. Johnsen and McMahon (2005), as well as Tagoe et al. (2005), provide substantial empirical evidences that financing behavior differences do exist even after controlling for other relevant influences on SME financing choices such as enterprise size, business age, profitability, growth, asset structure and risk.

29.2.2 POH Prevalence

Although many factors affect the financing of SME, but one kind of point which R&D of SMEs must be funded primarily by internal finance is prevalence. Usually based on the existence of information asymmetries between SMEs and suppliers of external finance, SMEs should obey the rule of pecking order hypothesis (POH). This point of view in Cressy and Olofsson's paper (1997) reflected, through the investigation of papers selected from a conference financing SME, most authors were agreed with this point by empirical research. Using newly available data,

Himmelberg and Petersen (1994) investigate a panel of small firms in high-tech industries, and find an economically large and statistically significant relationship between R&D investment and internal finance.

29.2.3 The Importance of Equity

Hussain et al. (2006) are also agreed with POH, in terms of initial funding, a large proportion of respondents relied on inside financial source, but with the age growth, the firms are likely to find financial support from outside, such as the equity venture capital. VC is thought one important financial source. Sjögren and Zackrisson (2005) present a unique empirical material on the financing of high technology small firms (HTSFs), the HTSFs in the study have a preference for equity financing, such as VC. Muller and Zimmermann (2009) find equity may be more important for young companies which have to rely on the original equity investment of their owners since they have not yet accumulated retained earnings and can rely less on bank financing. Allen et al. (2012) show alternative finance constitutes the most important form of external finance, which takes the key role in innovation of SMEs.

29.2.4 The Development of Relational Debt

Although debt market is vulnerable to adverse selection problems because of asymmetric information about risk characteristics and default probabilities, the relational debt conquers this defect. Berger and Udell (2002) and Moulton (2007) share the same view that the relational proxies that the lenders rely on are behavioral impressions, reputation information, and financial narratives that explain information on credit reports. David and O'Brien (2006), David et al. (2008) recognize debt is heterogeneous. Hormiga et al. (2011) highlight the key role played by relational debt in new business start-ups.

With the development of relational debt, banks join in the venture. Apart from VC, Wonglimpiyarat (2007) think SME bank in Thai, which gearing towards helping technology-based businesses create new innovation. In China, Sci-Tech bank emerges, like SME bank in Thai, it funds SME. Furthermore, it provides bi-styles investment, namely credit and equity investments. But the relationship between the newborn with VC firm is not discussed.

29.3 Regulatory Game Model

29.3.1 Analysis of Game's First Target

VC firm makes equity investments for SMEs, high risks and high returns stimulate VC firm makes investment for seed stage and industrialization stage. After Sci-Tech bank and VC firm make investment for the same venture, if the risk of technological innovation of SME is not successful, the Sci-Tech bank will receive its right of patented technology, whereas VC firm will not have anything. This request is not only for VC firm which must try to ensure the success of technological innovation, but also tends to go cooperation with the Sci-Tech bank. The Sci-Tech bank adopts the way of equity and debt investment, only for premium income after the success of technological innovation, not for the share of the company. So it is the very small number of SME's shareholders, it will have more difficulty in information collecting but only to increase the regulatory costs. This feature tends to make it go cooperation with VC firm. After cooperation, the deployed supervision or costs of gathering information of the Sci-Tech bank will influence the final profitability.

Game analysis of the two can be seen in Fig. 29.1. From the perspective of the Sci-Tech bank, after the initial financing, whether or not it goes into cooperation with VC firm, it will deploy different numbers in regulatory costs, but when it chooses the cooperation, the risks can be reduced. For VC firm, if the two sides have chosen to cooperate, its regulatory costs will be reduced, this part of the regulatory costs will be assumed by the Sci-Tech bank. When unilateral cooperation, there will be a corresponding increase in the costs of the cooperation side, which is unfavorable option for VC firm. The Sci-Tech bank is the new emerging bank in last two years, so VC firm chooses noncooperation program which has little effect on its earnings, so that they do not deploy more regulatory costs as well as not reducing regulatory costs.

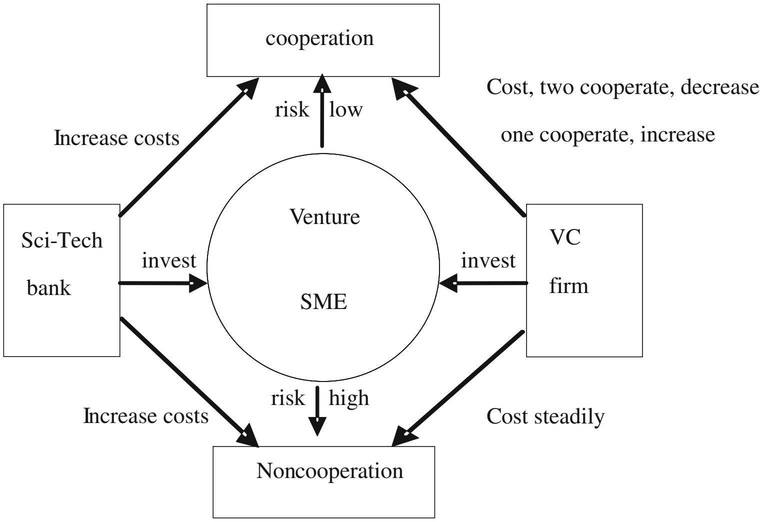

Fig. 29.1 Sci-Tech bank and VC firm analysis of the game

29.3.2 Model Hypothesis

Hypothesis 1 the Sci-Tech bank and VC firm are rational economic actors, and the two both invest SME.

Hypothesis 2 the game, which the Sci-Tech bank and VC firm invest in SME at the same, is limited. The funds in technological innovation are continuing. Technological innovation life cycle is divided into three stages: seed, industrialization and maturity stage, but in the market, VC firm‘s investment is mostly injected phased mode. The Sci-Tech bank is also assuming a phased investment, competing with VC firm. The game between the two will be carried out within a limited time, with the number of the time determined. It fits with repeated game theory of repeating times to determine limited times, considering the (T-1) times and using the strategy other than repeated 2-time equilibrium strategy. This will not yield more than to adhere to the Nash equilibrium. At this stage, due to the presence of changes in regulatory costs, with the changes, the Pareto optimal solution obtained in the limited game will not change.

Hypothesis 3 the probability of success of SME innovation is P. VC firm adopts an equity investment, accessing a business success profit of Y, or otherwise 0. The Sci-Tech bank invests mainly in the form of debt and equity, only to get bonus points. If SME innovation gets succeed, the Sci-Tech bank makes profit of X. After the two make investment for SME, the regulatory costs are large enough to be able to influence their profits. If they cooperate, C_1 represents regulatory costs deployed by the Sci-Tech bank. When unilateral cooperation, the cooperative side will increase C_2 (the regulatory costs), that is, the profit will be decreased the same

Table 29.1 The Game Rectangular Table

VC STB	Cooperation	Noncooperation
Cooperation	$P(X-D)+D-C_1$; $PY+C_1$	$P(X-D)+D-C_2$, PY
Noncooperation	$P(X-D)+D-C_3$; $PY-C_2$	$P(X-D)+D-C_3$, PY

STB stands for Sci-Tech bank; VC stands for VC firm

amount. When the Sci-Tech bank is non-cooperative, it will cost more C_3 to send to monitor and collect information, then the profit will be reduced the same amount. When VC firm is not cooperative, which will not influence its profits, so it will not send more regulatory costs. D stands for the right of patented technology.

29.3.3 Deduction of Model

1. When the Sci-Tech bank and VC firm adopt strategy (cooperation, cooperation), SME will make success of innovation and the two both make profits of $(X-C_1, Y+C_1)$. Whereas the innovation makes failure, the two will yield $(D-C_1, C_1)$;
2. When the Sci-Tech bank and VC firm adopt strategy (cooperation, noncooperation) and the innovation succeeds. The two will make profits of $(X-C_2, Y)$. Whereas the innovation fails, the two will yield $(D-C_2, 0)$.
3. When the Sci-Tech bank and VC firm adopt strategy (noncooperation, cooperation) and the innovation succeeds. The two will make profits of $(X-C_3, Y-C_2)$. Whereas the innovation fails, the two will yield $(D-C_3, -C_2)$.
4. When the Sci-Tech bank and VC firm adopt strategy (noncooperation, noncooperation), the innovation succeeds, the two will profits of $(X-C_3, Y)$, whereas the innovation fails, the two will yield $(D-C_3, 0)$.

Game rectangular table has a relationship as above Table 29.1.

29.3.4 Analysis the Relationship Under Different Circumstances

The Table 29.1 above is the expectation based on the successful probability of P, and we can see:

1. When $C_3 > C_2 > C_1$, the optimal equilibrium solution is (cooperation, cooperation). It can be seen that when the Sci-Tech bank deploys the largest cost C_3

when it chooses noncooperation, the Sci-Tech bank's management of risks will increase, so that it will correspondingly increase the regulatory costs. In the optimal equilibrium solution, in addition to normal receipts, the VC firm also obtains as part of regulatory costs which are assumed by the Sci-Tech bank, both reach to benefit the most.

2. When $C_3 > C_1 > C_2$, the optimal equilibrium solution is also (cooperation, cooperation). Even if in the cooperation the Sci-Tech bank deploys C_1 more than the cost of unilateral cooperation C_2, it does not influence the optimal balance between the two combinations.
3. When $C_1 > C_3 > C_2$, there should be a balanced mix. Let assume the cooperation probability of the Sci-Tech bank α, the cooperation probability of VC firm β.

$$E(ST) = (C_2 - C_1)\alpha\beta + (C_3 - C_2)\alpha + P(X - D) + D - C_3 \tag{29.1}$$

$$E(VC) = (C_1 + C_2)\alpha\beta - C_2\beta + PY \tag{29.2}$$

$$\frac{\partial E(B)}{\partial \alpha} = 0 \Rightarrow \beta = \frac{C_3 - C_2}{C_1 - C_2}; \frac{\partial E(V)}{\partial \beta} = 0 \Rightarrow \alpha = \frac{C_2}{C_1 + C_2}$$

The two cooperation probability is $\frac{C_2(C_3 - C_2)}{C_1^2 - C_2^2}$, mainly depending on the size of the difference between $(C_3 - C_2)\,and\,(C_1 - C_3)$. In reality, if the cost of cooperation between the two is the largest, the Sci-Tech bank should rationally estimate their possible values and seek the most favorable solution.

4. When $C_1 > C_2 > C_3$, Nash equilibrium is (noncooperation, noncooperation). When C_3—the regulatory costs, which the Sci-Tech bank adopts, are the least. As the same probability of gains, the rational Sci-Tech bank should choose the non-cooperative strategy.
5. When $C_2 > C_3 > C_1$, the optimal equilibrium are (noncooperation, noncooperation) and (cooperation, cooperation). There is a coordination game between the two, and individual rationality and collective rationality do not deviate, so it can be taken into equilibrium. But the two strategies' return value are not the same, because of $C_3 > C_1$, then (cooperation, cooperation) is the Pareto dominant. It can be seen that the two should expand their transparency of information, selecting the appropriately beneficial strategy.
6. When $C_2 > C_1 > C_3$, the optimal solution is (noncooperation, noncooperation). When the unilateral cooperative side deploys the biggest cost C_2 to cooperate. So the rational game between the two sides should select the non-cooperation strategy.

From the limited game above, we can see that after the Sci-Tech bank and VC firm investment, due to change in regulatory costs, the relations between the two competing game changes. In summary, in reality, the rational Sci-Tech bank will avoid the deployed highly regulatory costs, seeking assistance to reduce regulatory and information costs. Because of the possibility of mixed equilibrium, when it cooperates with VC firm, it should make the best cost supervision model program.

29.4 Conclusion

This article explores the game after the Sci-Tech bank and VC firm initial investment in SME, the two making a choice of the dynamic trend of cooperation can avoid a part of risks, and can reach a Pareto optimal in cooperation of the game. It can be seen that it is more conducive to strengthening the monitoring of risk in cooperation between the two. The continued funds injection can ensure that SMEs face the pressures and risks from the technology, market and management, which can solve the follow-up venture funds.

A few tips of how the Sci-Tech bank in China develops are below:

1. The Sci-Tech bank should keep in touch with the government, which can promote communication between the Ministry of Finance and the China Banking Regulatory Commission. Under the good investment environment, the Sci-Tech bank should make good use of given preferential.
2. There is a necessary to build a solid relationship between the Sci-Tech bank and SME. Strengthening the information transparency and avoiding the information asymmetry can ensure the Sci-Tech bank to make the determination to continue invest in SME.
3. In the later period of investment of SME, the Sci-Tech bank should formulate effective cost allocation plan reasonably and develop the cooperation partner with VC firm. Meanwhile, it also should actively strengthen cooperation with other organizations for the information transparency, such as the guarantee company and other banks.

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Chapter 30
Technical Innovations and Demand–Supply Models of the Taiwanese Tea Industry After Joining WTO

Tain-fung Wu and Chih-lan Kao

Abstract Having joined WTO, the tea industry in Taiwan faced international competition, and it resulted in the transformation of production technology and quality upgrading. In this paper, we aimed to examine how technical innovations drive industry transformation and upgrading in Taiwan's tea industry, and using an econometric model (3SLS) to analyze the effects of different economic variables on import and export of the Taiwanese tea. Data sourced from overall statistical database of DGBAS 1990–2011. The research found that "Whether Taiwan to join the WTO or not" had a positive correlation with "the difference between import and export of Taiwanese tea". The study showed that on the supply side, Taiwanese tea industry had competitive advantage with high-quality technology in an international market; on the demand side, the domestic market was expanded due to the successful upgrading of tea technology; on the marketing side, those branded Taiwanese tea drove the upgrading of Taiwanese tea.

Keywords Demand–supply models · 3SLS · Taiwanese tea · Technical innovations

30.1 Introduction

Since Taiwan joined WTO in 2002, tea becomes a free import product, large amounts of tea which transfers to domestic sale market. In addition, imported teas from Vietnam, China and Sri Lanka entering Taiwan with their cost advantages, therefore the Taiwanese tea market becomes more competitive (Qiu 2007). The Taiwanese tea industry faces global competition and business environment

T. Wu · C. Kao (✉)
Department of Business Administration, Asia University, Taichung, Taiwan
e-mail: lan_jay@ymail.com

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becomes increasingly difficult. Due to the Taiwanese tea industry transforms from export to import, in order to run the industry continuously, it must transform from a traditional manufacturing to a market-oriented production and sales professional industry, with using technology transformation and management to establish product differentiation and standardization (Xu 2005).

Moreover, the Taiwanese tea market opens after joining WTO, competition in domestic tea market becomes significantly the same as international tea market. As the world tea market is multiple competitive and shock.

There are technologies enhancements on tea cultivation and field's management in Tea Research and Extension Station (TRES), which people hope to find the most suitable species for different environment in different tea area and planting methods. Recently, Tea Research and Extension Station (TRES) notice the idea of intellectual property, for which research results and technologies can be protected by patent.

In this research, economic factors of the import and export volumes of Taiwanese tea and influence are analyzed in order to understand the general development of Taiwan's tea industry, as well as viewing the change of import and export volumes of Taiwanese tea after industrial technology upgrading and technology innovation management in the industry since joined WTO. Meanwhile, we observe and experiment the development trend of competitive power in the domestic and international tea markets with specific quantitative data.

Furthermore, tea industry in Taiwan faces industrial upgrading and innovation after joined WTO, we analyze whether assisting tea farmers (innovative business including production, technology management and marketing and so on.) with technology transformation and technology management from TRES can bring competitive advantage to Taiwanese tea industry or not, and we explore the differences between import and export of Taiwanese tea as the theoretical basis of this study. We also analyze the differences between import and export of Taiwanese tea with the following economic variables: "Whether Taiwan to join the WTO or not", "Consumer Price Index", "Export Price Index", "Import Price Index", "Economic growth rate", "Average exchange rate", "National disposable income", "Per capita private consumption expenditure", "National income" and "Tea production (British tonnes)", and then we explore the correlation of supply/demand connotations. Research results of this paper may provide references about industrial technology upgrading and transformation strategies for tea producing countries in Asia.

30.2 Literature Review

30.2.1 Technology Innovation of the Tea Industry in Taiwan

The development of Taiwanese tea changes with the times. After joined WTO, Taiwan faced more competitive pressure from imported teas. However, TRES still felt cautiously optimism about the prospect of Taiwanese tea. In response to competitive conditions among foreign products after joined WTO in 2002, the government carried out several policies to enhance Taiwan's competitive power, such as Taiwanese tea was mainly for domestic sales and supplemented by exports, adjusting domestic production scale, reducing production cost and enhancing quality. Besides, TRES applied three coping strategies to face competitive pressure. First, it targeted to produce high quality tea. In order to achieve this goal, improvements were made on the technology of tea production, and tea farmers in those main tea fields were guided to set up their brands that the high quality Taiwanese tea could be distinguished from cheap imported teas. Secondly, TRES assisted to process grading and packaging, and sales promotions in domestic or foreign exhibitions, and developed diversified tea products continuously for market expansion. Moreover, in 2001, TRES began to promote strategic alliance approach which combined with farmers' production and marketing group and farmers and business groups, and then to expand both domestic and foreign markets through these organizational forces. Thirdly, TRES guided and assisted tea farmers to process business transformation, which developed tourism and leisure, and strengthened the combination of tea, culture, leisure life to advance tea industry upgrading (Xiao 2007).

In addition, TRES revised the "Taiwan Good Agricultural Practice (TGAP)" and "Taiwan Good Agricultural Practice of Organic Tea" during 2005–2007, for which tea farmers were guided to record their productions accordingly. Technology Management enabled teas to be recorded and verified during productions, processing, packing, transportation and sales distribution, so consumers could trace the origin of tea and its production and cultivation process from the barcode on the packaging. Since 2004, TRES promoted the "Tea Merchants and Farmers Cooperation Scheme", which tea merchants and farmers cooperated to control fully the quality of tea by pesticide residues detection. In 2006, because of matching up the "Traceability System of Taiwanese Agricultural Products", TRES assisted tea farmers to fill in production records for setting up files (Website from Council of Agriculture 2012). Legal certification organizations of organic agricultural products were founded since 2007 in Taiwan, there have been 92 certified organic tea farms. "Agricultural Production and Certification Management Act" was announced on 29th January 2007 by the government, and the use of three certified labels—OTAP (Organic Taiwan and Traceability Agriculture Product), UTAP (Ubiquitous Taiwan and Traceability Agricultural Product), TAP (Taiwan and Traceability Agriculture Product) were officially started on 14th June 2007. Besides, from 2009 onwards, all organic agricultural products were changed to use OTAP labels, thus consumers could identify safety agricultural products, and they could buy with confidence in return. Safety agricultural products were based on the implementation of traceability system. From 2010 onwards, labels of good agricultural products (CAS) were changed to UTAP labels, and traceability system will be implemented for all domestic agricultural products in 2015. Additionally, from 2009 onwards, organic agricultural products should be labeled after pass the verification before selling, and all organic agricultural products for selling should be verified and labeled in accordance with law (Chen 2009).

As technology is developing rapidly, TRES explored and tested with applied science to choose the best and strongest tea species, for which would be suitable to grow under Taiwan's soil and climate conditions, and these species would be promoted breeding; in order to enhance Taiwan's competitive power in the international tea market, tea tree planting technology, productions and processing technology for all tea species were improved as well as cost reduction; developed diversified products, optimized the quality of tea and its use value; tea culture promotion and assisting expansions of domestic and foreign markets could let the tea industry run continuously. Not only examined on basic, developing and perspective research, but also including examined on raising and planting improvement of species, and improvement of tea production technology. Skill of tea personnel were advanced by professional training courses (Fan 2006).

Technology management was an improving motivation at tea industry. TRES helped to train tea farmers for the latest technology of planting and tea production. The development of Taiwanese tea industry could be enhanced due to the improvement of technology and management, which enabled Taiwan to have a place on the international stage. Although there were professional tea experiment stations that they provided the core of heritage for the whole industry of tea, it was still not enough for tea industry in Taiwan to continue its developing. Therefore, the tea industry needed to link up the related industry chain, adjusted the way of testing and research with the change of domestic and foreign situation at any time, applied the new technology to advance the technology of tea production and sales, kept assisting and promoting this new technology, as well as strengthening the structural of the whole industry that enabled the traditional industry to be modernized and technology transformed, and this drove development in tea farms and upgraded the industry. As a result, the tea industry was consolidated and the above methods became the basis for continuing developing the tea industry.

30.2.2 Import and Export Volume in Taiwanese Tea Industry

It is shown in Fig. 30.1, that import (the line with rhombus) reaches peak in the period 2004–2008, which the highest point is in 2008 with 27,289.33 tonnes; export (the line with square) reaches the peak in the period 2004–2008, which the highest point is in 2005 with 9,942.82 tonnes. Generally, the import volume of Taiwanese tea is greater than its export volume, particular in the period 2004–2008, the export volume of Taiwanese tea is much lower than its import volume.

In Fig. 30.2, we see that the export price of Taiwanese tea per tonne (British) is higher than its import price per tonne, and this demonstrated that higher profit is

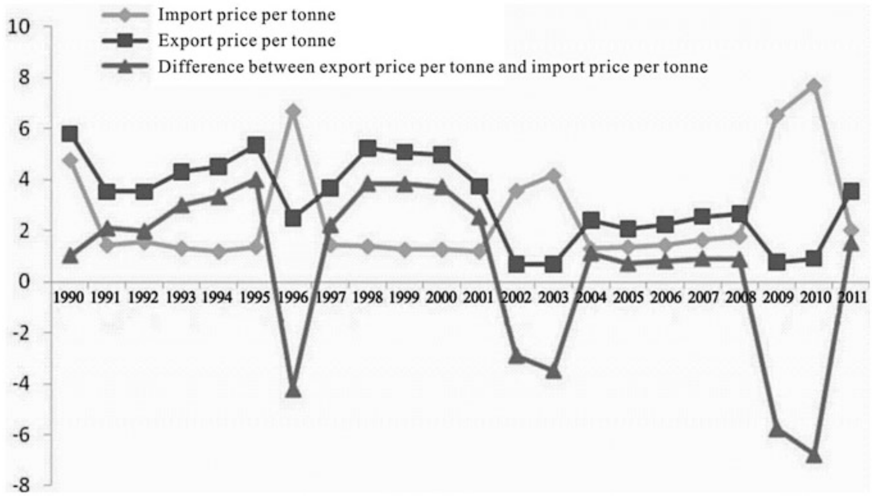

Fig. 30.1 Distribution of import and export volumes of Taiwanese tea from 1990 to 2011 (Qiu 2007)

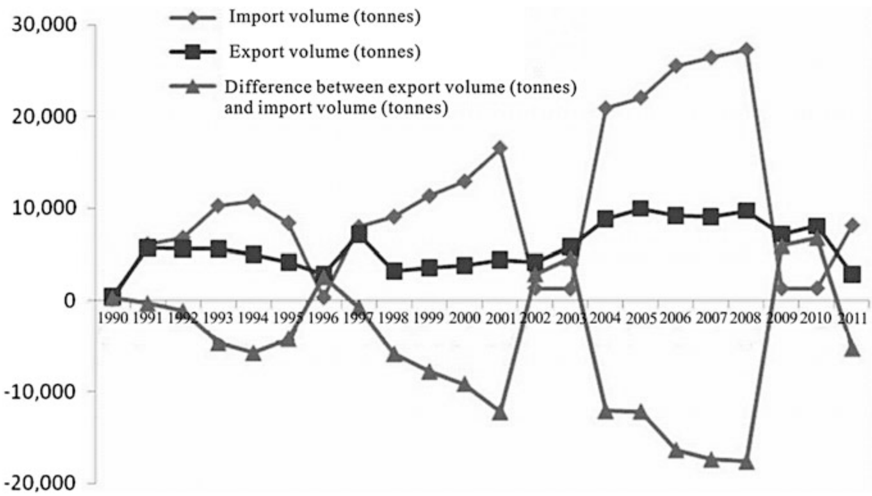

Fig. 30.2 Distribution of import and export prices of Taiwanese tea from 1990 to 2011[See note Query system of agricultural trade statistics (2012)]

made by the export of Taiwanese tea. It is noteworthy that the difference between import price and export price is large in the earlier period, but this difference is trend to narrow in these recent years.

30.3 Methodology

30.3.1 Econometric Models

As considering the high correlation between independent variable and dependent variable, we chose three-stage least square to be analysis model (Draper and Smith 1998; Neter and Wasserman 1996; Lardaro 1993) for the empirical way of economic variables. The choice of variables was divided into supply side and demand side to create the simultaneous equations model with the combination of supply and demand. While setting each structure, we had to make sure whether the setting was correct or not (Jian et al. 2010), that meant the setting should fulfill "necessary condition" and "necessary and sufficient condition" at the same time[1].

30.3.2 Data Sources

Data was selected in the range of period 1990–2011, using 22 years of annual data in total, and overall economic variable data source was taken from overall statistical database of DGBAS. Data source of Import and export of Taiwanese tea was taken from the Query system of Agricultural trade statistics (2012).

30.4 Data Analysis

In this research, we used three-stage least square to predict the effects of each independent variable on the difference between the export volume of Taiwanese tea and the import volume of foreign tea. The three-stage least square involved three solving steps. The first step was using first-stage regressions to get the predictive value of the endogenous regresses. The second step was using two-stage least-squares to get the residuals in order to predict the cross-equation correlation matrix. The last step was to evaluate the 3SLS. The effects of each independent variable on the difference between the export volume of Taiwanese tea and the import volume of foreign tea would be shown by these three solving steps.

[1] Assume that there is n number of behavioral structures in a model, each behavioral structure involves one or multiple Intrinsic variables. In addition to the behavioral structure is being discussed here, there are $(n - 1)$ number of structures, and functions in the event of $(n - 1)$ structures, at least having one $(n - 1)$ determinant of the value is not equal to zero, therefore this kind of behavioral structure is identified as fulfilling "necessary condition" and "necessary and sufficient condition" at the same time.

30.4.1 Supply and Function

Supply function is shown in Table 30.1, independent variables of tea plantation area, farm yield per unit area and the difference between the export volume of Taiwanese tea and the import volume of foreign tea are significant. If the difference between the export volume of Taiwanese tea and the import volume of foreign tea (increase in exports or decrease in imports) is lower, the supply of the domestic market will be higher.

Demand function is shown in Table 30.2, independent variables of whether Taiwan to join the WTO or not, import price index, national disposable income, Per capita private consumption expenditure, national income and the difference

Table 30.1 Constructivist supply function

Independent variable Variable	Standardized regression coefficients H0; Parameter = 0	T Estimate	Probe > 0
Constant term	340.432	20.388***	0.003
Tea plantation area	120.345	14.341***	0.000
Farm yield per unit area	70.35	23.783***	0.000
Difference between the export volume of Taiwanese tea and the import volume of foreign tea	−11.388	−9.340***	0.001

Adjusted R2 = 88.3 %
***represent statistical significance at the 1%

Table 30.2 Constructivist demand function

Independent variable Variable	Standardized regression coefficients H0; Parameter = 0	T Estimate	Probe > 0
Constant term	−50.432	−0.888	1.762
Whether Taiwan to join the WTO or not	4.833	3.765***	0.000
Consumer price index	7.35	4.813***	0.000
Export price index	1.388	3.380	0.111
Import price index	−5.730	−10.888***	0.000
Average exchange rate	−0.072	−0.081	1.381
National disposable income	5.343	9.350***	0.000
Per capita private consumption expenditure	1.097	0.074***	0.134
National income	9.181	5.605***	0.007
Difference between the export volume of Taiwanese tea and the import volume of foreign tea	−10.338	−9.887***	0.000

Adj R2 = 69.5 %
***represent statistical significance at the 1%

between the export volume of Taiwanese tea and the import volume of foreign tea are significant. If the difference between the export volume of Taiwanese tea and the import volume of foreign tea (increase in exports or decrease in imports) is larger, the demand of the domestic market will be lesser.

30.4.2 Analysis on Import and Export Markets of Taiwanese Tea

It is shown in Table 30.3, that the explained variance of overall regression model reaches 76.0 %. variables of "whether Taiwan to join the WTO or not", "Consumer Price Index", "Import Price Index", "national disposable income", "per capita private consumption expenditure" and "tea production (tonnes)" reaches the significant level. The effects of these six variables on the "different between import and export volumes of Taiwanese tea" as the following (Table 30.3):

30.4.3 Analysis and Discussion

In general, the impact of "whether Taiwan to join the WTO or not" on "differences between import and export volumes of Taiwanese tea" was significant in a positive direction that 1.633 affected unit could be expanded. This demonstrated that after Taiwan joined the WTO had an effect on advancing the different between

Table 30.3 Constructivist difference between the export volume of Taiwanese tea and the import volume of foreign tea

Independent variable Variable	Standardized regression coefficients H0; Parameter = 0	T Estimate	Probe > 0
Constant term	−158.177	−0.288	1.314
Whether Taiwan to join the WTO or not	1.633	4.811***	0.000
Consumer Price Index	5.697	3.613***	0.000
Export Price Index	0.261	1.080	0.111
Import Price Index	−1.330	−4.306***	0.000
Economic growth rate	−0.723	−1.779	0.081
Average exchange rate	−0.372	−0.881	0.981
National disposable income	−4.353	−3.207***	0.000
Per capita private consumption expenditure	−5.997	−2.174***	0.000
National income	4.183	1.605	0.887
Tea plantation area Farm yield per unit area	0.614	2.519*	0.04

Adj R2 = 76.0 %
***represent statistical significance at the 1%

import and export volumes of Taiwanese tea, which meant that technology transformation and management in the Taiwanese tea industry enlarged the external market for the Taiwanese tea industry after joining WTO.

The effect of "Consumer Price Index" on the "difference between import and export volumes of Taiwanese tea" was significant in a positive direction that 5.697 affected unit could be expanded. Because of an increase in export or decrease in import, there was enhancement effect on the difference between import and export volumes of Taiwanese tea. Similarly, the effect of "Import Price Index" on the "difference between import and export volumes of Taiwanese tea" was significant in a positive direction that −1.330 affected unit could be reduced. This demonstrated that the export of Taiwanese tea would be benefited while import price increased. Meanwhile, it also verified that technology transformation and management of the whole industry under the situation of the rising of consumer price level had an effect on advancing the difference between import and export volumes of Taiwanese tea, which created an advantage condition for the export of Taiwanese tea.

The increase of "national disposable income" and "per capita private consumption expenditure" significantly affected the "difference between import and export volumes of Taiwanese tea" in a negative direction, which could reduce −4.353 and −5.997 affected units respectively. This showed that after the increase of national disposable income, the demand for imported tea would increase too, and it would lead to enlarge the difference between import and export volume.

Besides, the enlargement of "Tea plantation area farm yield per unit area" significantly affected the "difference between import and export volumes of Taiwanese tea" in a positive direction, which could increase 0.614 affected unit. This indicated that an increase in tea supply could enable a rise in export volume or a decrease in import production, thus enlarging the level differences of both import and export. It also verified that technology transformation and management of the tea industry enabled the effect of "Tea plantation area Farm yield per unit area" on the "difference between import and export volumes of Taiwanese tea" to develop in a positive direction, and it was possible to lead an increase in export or a decrease in import, with resulting in the enlargement of the difference between import and export volumes.

30.5 Conclusion and Suggestion

30.5.1 Conclusion

The demand side of the Taiwanese tea market is greater than its supply side; "whether Taiwan to join the WTO or not" and "Consumer Price Index" correlate positively with the "difference between import and export volumes of Taiwanese tea", which shows that an increase in consumer price index after joining WTO can shorten the differences between import and export of tea; "Import Price Index", "national disposable income" and "per capita private consumption expenditure" correlate positively with the "difference between import and export volumes of Taiwanese tea", which demonstrates that the export of tea will be benefited from an increase in import price, while rising in national income and consumption increase the demand for foreign import tea. This indicates that an increase in the supply of tea can make export rise or import fall, as a result, the difference between import and export volumes is enlarged.

30.5.2 Analysis on the Effectiveness of Technology Transformation and Management in Taiwanese Tea Industry

1. International supply-side: Technology of Taiwanese tea industry for high quality production with competitive advantage in the international market.

Through these empirical data, the study found that export of Taiwanese tea is greater than import after joined the WTO. This shows that external market is expanded after joining WTO, whereas "production of quality safety products of tea products" and "developing the regional characteristics of teas" has their effectiveness. Methods of "system for assisting the cooperation between tea merchant and farmer and enhancing geographical indication", "strengthening the promotion of the traceability System of tea" further optimize the tea industry in Taiwan, and let Taiwan have a place within the borderless tea trade.

2. Domestic demand: Tea technology enhancement and domestic market expansion.

The research found that an increase in national disposable income enables import of tea significantly higher than export. Although facing import openness of China and Vietnam, as well as some wholesalers in Taiwan mix with some low quality tea to obtain more profit and the original price of Taiwanese tea is disordered by this, Taiwanese tea farmers have skillful tea-making technology which other countries haven't reached at this level yet, so it becomes the biggest advantage of Taiwan. Domestic market in Taiwan is expanded by improvements of "assisting tea farmers to enhance tea-making technology" and "holding education training on time".

3. Marketing strategy: Branded Taiwanese tea drives Taiwanese tea upgrading.

Providing high quality and safe tea product is one of marketing strategies to grab the market share in the domestic market. Tea farmers used the overall strategies of "assisting to expand export supply chain" and "introducing the best-label tea to establish the image of "MIT IS GOOD", and with the effect of brand stacking from other MIT brands to reduce the domestic tea production cost and even the international marketing cost.

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Chapter 31
Technological Leapfrogging Ability Study and Policy Suggestion for Strategic New Industries

Jie Liu and Li-ping Fu

Abstract Knowledge potential exists to promote knowledge transfer, while technological leapfrogging is the process of knowledge acquisition and diffusion process, in this process, technical leapfrog ability enhancement. This article from the perspective of knowledge potential technical leapfrog ability, put forward four dimensions of knowledge-scanning capability first, ability to obtain knowledge, learning ability, innovation ability of knowledge, through the construction of technical leapfrog ability lifting mechanism model, analyzed the technical leapfrog ability mechanism, so as to enhance the ability of Chinese enterprises technological leapfrogging forward suggestion.

Keywords Knowledge potential · Policy suggestion · Strategic new industries · Technological leapfrogging ability

31.1 Introduction

The strategic new industries (SNIs) were the products of close combination of new industries and new technology. They represented the future of the national economic and technology and had leading action to other industries. The development of the SNIs was focused on more and more by central and local governments. On the Two Conferences in 2012, CPPCC Chairman Jia Qing-lin pointed out that the upper design and scientific layout for SNIs should be strengthened.

China was in the relative backward period of technology development. To achieve scientific and technological innovation, it was necessary to achieve technological leapfrogging ability and catch up the leaders by technology-driven, market

J. Liu (✉) · L. Fu
School of Management Engineering, Tianjin University, Tianjin, Peoples Republic of China
e-mail: liujie32@tju.edu.cn

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control and using the reasonable channels on the base of other countries. Parts of the national SNIs had accumulated some advanced technological capabilities and had the possibility to catch up or even across the leaders. While how to make full use of the technology resource and play the core competitiveness of technological ability was the way of victory to achieve sustainable competitiveness.

31.2 Technological Leapfrogging Ability and Dimension Design

The study of technological ability generated from the practice of technology catching up in developing countries in the 1980s, along with the business growth theory and business ability theory. Frances Stewart firstly proposed the definition of technological ability: technological ability was the ability to choice, use and improve some technologies, and create new technologies within the habitat. This ability was the most essential features for economic development (Stewart 1984). The research team of technological ability in Thailand defined the technological ability as "the combinations of independent technological learning ability, independent technology creating ability and independent technology tracking ability" (Tyler 2001). Lall enterprise that technological ability was the key factor for developing countries to succeed. Technological ability referred to the ability to absorb, imitate, apply and transform relative technologies from products, production processes and production organizations, including the ability of technological levels, technical and management organization (Lall 1992). Wei Jiang defined it from the perspective of knowledge: technological ability was the sum of all the endogenous technology-related knowledge to support organization technological innovation (Jiang 2006).

Many domestic and foreign scholars defined technological ability from different angles which was the base of technological leapfrogging study in this paper. Technological ability was the base of technological leapfrogging and the core factor for leapfrogging success (Zhi-jian 2003). In this paper, technological leapfrogging ability was technological ability in the course of technological leapfrogging in short. Yao Zhi-jian divided technological ability into two aspects from the angle of course. The first aspect included technological monitoring ability, technological learning ability and technological leapfrogging implementing ability. The second aspect included technological scanning ability, choice ability, learning ability, developing ability and supporting ability.

The essence of technological ability was knowledge (Martin 1984). The technology and technological ability of an enterprise must be combined through knowledge (Meyer and Utterback 1993). In this paper, the authors held that technological ability belonging to knowledge category. So technological leapfrogging ability could be divided into the four dimensions of knowledge scanning ability, knowledge acquisition ability, knowledge learning ability and knowledge innovation ability.

31.2.1 Knowledge Scanning Ability

Knowledge scanning ability was the ability of collecting information widely, tracking the most frontier technology and trend through perfect information network of the enterprises. The international network was the most important way for enterprises in less developed regions and countries to search techniques. The trail change of technology in developed countries offering chance for the less developed countries. The inner universities, research institutes, purchasers and suppliers would be the important technology sources for the enterprises.

31.2.2 Knowledge Acquisition Ability

Knowledge acquisition ability was to choose a feasible low-cost access and transfer the target technological knowledge to the inner ability of the enterprises. Firstly, the technological knowledge was introduced into the enterprises from the exterior through scanning, choosing and negotiating. Secondly, the external technological knowledge and the inner technological knowledge were blended together.

31.2.3 Knowledge Learning Ability

The new external technological knowledge was internalized into the enterprise's own knowledge systems and then commercialized as products. There were different knowledge learning ways, such as reverse engineering, learning of design drawings and patents, technological learning in joint ventures and learning through OME.

31.2.4 Knowledge Innovation Ability

The enterprise used the early accumulated resources, realizing technology's commercialization, industrialization and internationalization, and gaining commercial interests through the own research and development.

In this stage, the enterprises often had their own independent research institutions, open innovation network, own brands and independent intellectual property

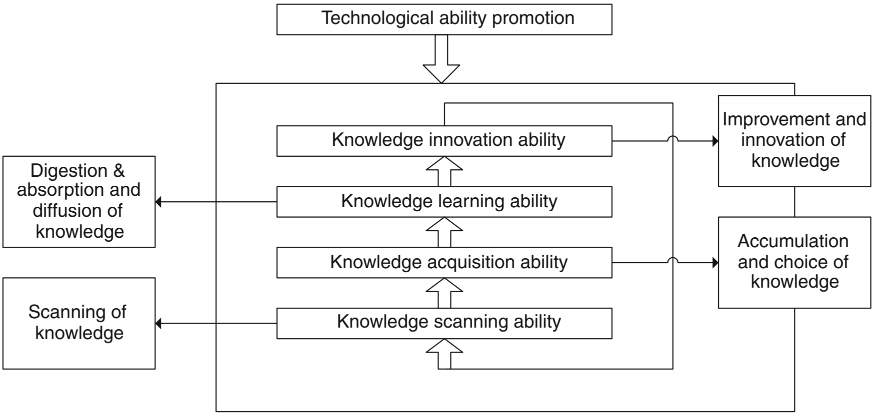

Fig. 31.1 4 dimension of technical leapfrog ability

rights. The new products often originated from internal technological breakthrough, especially the core technology. So the enterprise must have strong technical financial strength and risk tolerance.

In summary, technological leapfrogging ability was a set of knowledge scanning, knowledge learning, knowledge learning and knowledge innovation, which were independent and complementary. The last round technological ability improvement could promote the later round improvement (Hao-tian and Tian-ying 2007) (See Fig. 31.1).

31.3 Technological Leapfrogging Ability Mechanism Based on Knowledge Potential

31.3.1 Knowledge Potential Theory

In physics, an object at a certain location has a certain potential energy. Material and immaterial will diffuse from high potential energy to low potential energy. Knowledge was no exception in that the potential difference among the knowledge subjects must lead to some interaction (Yun 2011).

Du Jing put forward the concept of knowledge potential for the first time. She considered that different knowledge subjects have different knowledge stocks in some regions and the potential are different because of non-equilibrium of knowledge distribution (Yun 2011). Hu Han-hui considered that during the knowledge sharing, the knowledge absorption ability of the lower-potential subjects depended on the overlapping knowledge with the upper-potential subjects (Han-hui and An-cheng 2006).

The gap among knowledge subjects was a natural power to urge knowledge transferring and the imbalance of knowledge distribution was the main factor for knowledge potential. The upper knowledge potential subjects gained knowledge potential by own knowledge innovation, while the lower knowledge subjects gained potential either by absorbing new knowledge from upper ones or by investment of human and material resources. The knowledge inevitably transferred from the upper to lower, and the benefit of the upper ones can speed up the process.

By means of knowledge potential theory, this paper held that the sum of technological knowledge determine the technological ability of an enterprise. During the course of technological leapfrogging, the backward industries narrowed the gap with the advanced industries by knowledge transferring.

31.3.2 Technological Leapfrogging Ability Mechanism

Based on knowledge potential theory, knowledge transfer from lower to upper could be divided into four dimensions of preparation, occurrence, transfer and generation of new knowledge. Combined with the four dimensions of technological leapfrogging ability, this paper built technological leapfrogging ability mechanism (See Fig. 31.2).

1. Preparation stage of knowledge transfer:

For knowledge in certain regions or layers, some subjects which called high potential knowledge subjects, mastered frontier and wide knowledge, and the others which called low potential knowledge subjects, mastered backward and

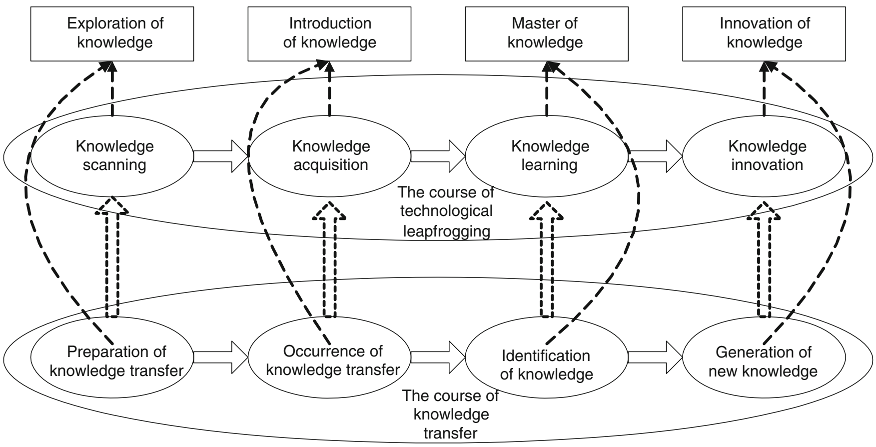

Fig. 31.2 Mechanism model of technical leapfrog ability promotion based on knowledge potential

narrow knowledge. The premise of knowledge transfer was: the low potential ones detected and explored deeply high potential knowledge in related fields, and found the knowledge matching to their own resources and abilities. The ability of researching for knowledge for low potential subjects affected the roads and ranges of obtaining knowledge.

This stage corresponded to researching and choice of technological knowledge during technological leapfrogging. The knowledge introduction should follow these stages: technology scanning, corresponding data and information collection, introduced knowledge set shown, feasibility assessment of technology's life cycle, potential return rate and development.

2. Occurrence stage of knowledge transfer:

While the low potential knowledge subjects searched and selected suitable knowledge, they would request the high potential subjects send knowledge. Because these courses need cost, knowledge could not be transferred until the knowledge was needed by the low potential subjects. The cost and expected return had direct proportion.

This stage corresponded to introduction of technological knowledge. There were many styles of knowledge introduction such as buying compete equipments, buying patents, buying licenses, buying design techniques and principal development. When the techniques were bought, the technicians would obtain knowledge not only from data but also from industrial fields. While contacting with the personnel of the knowledge source enterprise, the industrial inner personnel could master related techniques. When the source personnel left, they could guarantee the equipments' normal operation.

3. Identification stage of knowledge transfer

The transferred knowledge would be identified in low potential knowledge subjects, and accumulated static or dynamic. The knowledge transferred from high potential knowledge subjects would interact with original knowledge. The low potential knowledge subjects now had the ability to identify their effectiveness. The knowledge maternal which tiller effective knowledge would combine with the knowledge from external knowledge so as to build a new knowledge system. Then, the depth and wideness of the knowledge system of the low potential subjects would be expanded (Jing 2003).

This stage corresponded to learning of technological knowledge. After a relatively long time operation of the introduced equipments and techniques, the inner personnel would undergo the courses of "learning by doing", "learning by using" and "learning by training", and the new knowledge system would replace the system of the old equipment. The technological ability and level would be truly promoted while improvement of introduced knowledge and solve of difficult questions. At the same time, personnel mastering mast core techniques would be more and more.

4. Generation stage of knowledge transfer

The part of knowledge system of the low potential subjects which differentiated into effective knowledge would be broken while the external knowledge and accumulated knowledge were combined. Some stored knowledge would be activated and new knowledge different from transferred knowledge would appear through knowledge integration. The knowledge maybe promote the potential of the low potential subjects, even higher than the external resource knowledge.

This stage corresponded to innovation of technological knowledge. After a long time operation of the introduced equipment and techniques, the inner personnel built a whole knowledge system about the introduced knowledge even improved some components and processes to improve competitiveness.

In a word, the promotion of technological leapfrogging ability was a complex course of knowledge transferring. This course included four dimensions' evolution of knowledge scanning, acquisition, learning and innovation, and it would spiral rise instead of terminate. The enterprise would survey the external environment at a higher level and offer suitable technological recourses for strategic choices. With the accumulation of knowledge, the technological ability transferred sustainably and increased.

31.3.3 Enlightenment for Chinese Enterprises

The Chinese enterprises could not realize technological leapfrogging unless pay more attention to the following factors:

1. The promotion of technological leapfrogging ability was a course of continuous accumulation. When an enterprise entered a new technique region and wanted to realize important technological leapfrogging, it was important whether the enterprise could accumulate advanced technological ability, make up its own vacancy of knowledge and ability, open up new technological accumulation track, and accumulate new knowledge and techniques. Both the government and the enterprises should accumulate and promote technological leapfrogging ability premeditated.
2. The promotion of technological leapfrogging ability should fully use different technical knowledge resources. With the improving of techniques' comprehensiveness and complexity, the network based on knowledge built among organizations became a significant feature. An enterprise could not create all the need techniques from the inner. So, the backward enterprises with limited technical resources should make full use of external technological knowledge and needed to have the ability to establish or integrate into the knowledge network. Obtaining external technical knowledge was a direct complement to the enterprise's existing technical resources, and thus indirectly affected its ability to innovate. There were many channels to access to external knowledge

such as suppliers, customers, competitors, universities and research structure, and governments.

3. Focus on the coordinated development of the dimensions of technological leapfrogging ability. The dynamic evolution of technological leapfrogging ability was essentially the course of knowledge evolution, reflecting knowledge's scanning, acknowledge, learning and innovation. The fragment of the mental connection and neglect of a particular aspect would result in "barrel effect" and hinder the formation and upgrade of technical ability. Through efforts, so that the constitute dimensions of technical ability had been strengthened and improved to achieve overall optimization and coordinated development, in order to improve technological leapfrogging ability.
4. To break the ability of rigid, realizing dynamic and flexible technical ability. The technical ability and the enterprises' technological knowledge state were closely related. The stock, distribution, structure and flow of the enterprise technical knowledge built an enterprise-specific knowledge base, making enterprises to heterogeneity. However, the existing knowledge base may hinder the integration of new knowledge, especially the enterprises with large organization, complex product process and a long history, resulting in the rigidity of their own knowledge and rigid technological ability. It was hard for them to achieve the conversion of technical track and core competencies. Therefore, the enterprises should pay attention to maintaining the patency of the internal and external information, pay more attention to the trends of technological development.

31.4 Conclusion

This paper defined technological leapfrogging ability and designed its dimensions. Specially, technological leapfrogging ability was studied based on knowledge potential theory. Finally, enlightenment for Chinese enterprises was given.

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Chapter 32
Technology Imports, R&D Investment and Technical Efficiency of Chinese High-Tech Industry

Feng Peng and Ling Li

Abstract This paper examines the relationship between technology imports, R&D investment and technical efficiency of Chinese high-tech industry using provincial panel data for the period between 2000 and 2009. The results show that, although technology imports have no significant effects on technical efficiency, R&D has a positive and significant influence on the technical efficiency of Chinese high-tech industry, what's more, the interaction of R&D investment and technology imports promotes technical efficiency significantly. For policy makers, the results of our analysis suggest that adjusting trade structure and encouraging enterprises to increase R&D investment may significantly promote technical efficiency of Chinese high-tech industry.

Keywords High-tech industry · R&D investment · Technical efficiency · Technology imports

32.1 Introduction

Increasing attention has been paid to the development of China's high-tech industry in recent years, not only because its industrial output is more than any other country, but also because it produces and exports many technology-intensive and capital-intensive products. However, existing studies about its characteristic

F. Peng (✉)
Economics and Management School, Wuhan University, Wuhan, China
e-mail: pengfengs@163.com

L. Li
Research Center for China Industry-University-Research Institute Collaboration, Wuhan University, Wuhan, China

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show that the high-tech industry still in the low end of industry chain, and the export highly relies on processing trade (Srholec 2007). Whether it realizes sustainable development has become one of research hot spots. A number of studies offer the empirical basis from a perspective of productivity growth (Wang and Szirmai 2005, 2008). Most of them conclude productivity growth of the high-tech industry appear to result from technical progress rather than technical efficiency. There are remarkable differences between different high-tech industries, and the technical efficiency varies in terms of magnitude and significance across different regions (Tsai and Wang 2004; Zhang et al. 2012). A few studies have offered explanation for technical efficiency differences. Xu finds that technology policies have a positive impaction on increasing total factor productivity of high-tech enterprise in China (Xu 2008). Wu et al. (2010) use panel data model to analyze the effect of marketization and government intervention to the R&D total factor productivity and find that marketization has signific positive impact to the R&D total factor productivity but government intervention is the opposite. The human capital level, financial support level, industry export tendency and industry innovation character of domestic sector have significant positive impacts on long-term technical efficiency in domestic departments (Cheng et al. 2010). These literatures provide basis for technical efficiency differences in high-tech industry, but lack further analysis on technical efficiency from a perspective of technology imports.

Existing empirical literatures in regard to relationship between technology imports, R&D investment and technical efficiency are aiming mainly at industrial sector (Mendi 2007; Andersson et al. 2008; Dovis and Milgram-Baleix 2009; Parameswaran 2009), which lack empirical test for technological absorption of technology imports in Chinese high-tech industry. Moreover, the reforms in industrial structure significantly account for the sectoral heterogeneity of factor allocative efficiency during the industrial transformation process (Zhang et al. 2003; Chen et al. 2011), but existing empirical literatures always ignore the effect of the industry structure change. Consequently, this paper attempts to extend existing literatures from the following aspects: We estimate technical efficiency of China's high-tech industry by applying Malmquist index based on DEA, and examines the relationship between technology imports, R&D investment and technical efficiency by panel data. After that, we examine the effect of R&D investment on technical efficiency for the impact of industrial structure is taken into account. On the basis of empirical analysis of R&D investment and technical efficiency, we examine the absorbing capacity of R&D in technology imports. The paper is organized as follows. The next section provides the specification and estimation of the econometric model, and introduces the proxies for the relevant variables and data sources. Section 32.3 contains the analysis of the estimation results. In the final section some conclusions and policy implications are drawn.

32.2 Methodology

32.2.1 Model

The purpose of this study is to examine the relationship between technology imports, R&D investment and technical efficiency, and other influences such as human capital, foreign direct investment and structural change must be taken into account when we examine the relationship between technology imports, R&D and technical efficiency. However, the provincial data of human capital and foreign direct investment are unavailable. Given these facts, and for the sake of simplicity, the specification of the econometric model can be expressed in the equation:

$$lnEC_{it} = \beta_0 + \beta_1 lnEX_{it} + \beta_2 lnIM_{it} + \beta_3 lnRD_{it} + \beta_4 lnSC_{it} + \varepsilon_{it} \tag{32.1}$$

where EC_{it} is the technical efficiency; EX_{it} is the proxy for export; IM_{it} is the proxy for import; RD_{it} is the stock of R&D; SC_{it} is the proxy for structural change. β_1, β_2, β_3 and β_4 are the EC elasticities with respect to export, import, R&D and structural change, respectively; and ε_{it} is a random perturbation term. In order to examine potential interactions between R&D and export, and R&D and import from abroad, that is, the technological absorption based on R&D, we obtain the following relation:

$$lnEC_{it} = \psi + \gamma_1 lnEX_{it} * lnRD_{it} + \gamma_2 lnIM_{it} * lnRD_{it} + \varepsilon_{it} \tag{32.2}$$

where $\psi = \beta_0 + \beta_1 \mathrm{lnEX}_{it} + \beta_2 \mathrm{lnIM}_{it} + \beta_3 \mathrm{lnRD}_{it} + \beta_4 \mathrm{lnSC}_{it}$, γ_1 and γ_2 reflect the technological absorption ability of R&D with respect to export and import respectively. If γ_1, $\gamma_2 > 0$, then the technological absorption ability of R&D are higher.

32.2.2 Data

We use total factor productivity (TFP) as our measure of productivity in order to estimate provincial productivity and decompose TFP into technical efficiency and technical progress by applying Malmquist DEA. The output data used in the Malmquist DEA is gross industrial output value with the unit of RMB 100 million yuan at 2,000 price level, denoted by Y; The labor input, L, is annual employed workers with the unit of person in high-tech industry; The capital stock, K, is estimated at 2,000 price level by using perpetual inventory method, estimating the capital stock in the first year, and depreciation is 9.6 %. R&D investment has been approximated by various proxies: strength of R&D, total expenditure on R&D. We use R&D stock as a proxy for R&D investment, which estimated at 2,000 price level by using perpetual inventory method, denoted by RD. The R&D stock in the first year follows Zhang et al. (2012), and depreciation rate is 15 %. We use shares of exports over total production as a proxy for export, denoted by EX; and use shares of imports over total production as a proxy for import, denoted by IM. The mean of capital stock share and employee share in high-tech industry can be serve as a proxy for structural change.

The paper chooses provincial panel data of Chinese high-tech industry for the period between 2000 and 2009 to examine the relationship between technology imports, R&D investment and technical efficiency. All the relevant data come from China Statistics Yearbook on High Technology Industry. According to the Statistics Yearbook, the high technology industry consists of manufacture of medicines, manufacture of aircrafts and spacecrafts, manufacture of electronic equipment and communication equipment, manufacture of computers and office equipments, and manufacture of medical equipments and measuring instrument.

32.3 Results

The economic variables are often non-stationary variables that can generate spurious causal relations. If the presence of a unit root is proved, it is necessary to assure the existence of a co integration relationship between the variables. The Eviews 6.0 software was used in the estimation. The results of the LLC, IPS, ADF and PP tests applied to the variables, indicate that the logarithmic series are stationary. We use Hausman test to determine whether there is random effects on cross-section, and apply redundant fixed effects likelihood test to determine whether there is fixed effects on time series. The results of estimation and tests are presented in Table 32.1.

As can be seen in Table 32.1, exports have no significant effects on technical efficiency. The explanation that exports have no significant effects on industrial efficiency may be that Chinese market economy system and market institutions are immature and under-developed. However, for Chinese high-tech industry, the better explanations may be fragmented international division and prevalent processing trade. In export-oriented processing trade, firms lack the enthusiasm of technology innovation, which can result in lower technical efficiency. Contrary to expectation, imports have negative impact on technical efficiency. The reason for that may be the processing trade that high-tech industry import large amount of components and parts highly integrated, then export after simple processing, which does not meet the condition of positive spillover effect presented by Blyde (2004), thus, it difficult for the firms to promote management efficiency and accumulate production experience, but the firms have come to rely on import of intermediate product.

Structural change has a negative effect on technical efficiency. The reason for that may be capital and labor concentrate on a particular industry (such as manufacture of electronic equipment and communication equipment), which makes marginal productivity and allocative efficiency decreased. According to the results, R&D could significantly promote technical efficiency. The reason may be non-state-owned firms, from an integral part of high-tech industry, pay more

Table 32.1 Estimation of the econometric model

	Model 1	Model 2	Model 3
C	−1.2054	−1.0978	−1.4374
	(−9.38)***	(−9.12)***	(−11.08)***
lnEX	−0.0073	−0.0487	0.0033
	(−0.37)	(−2.46)**	(0.17)
lnIM	−0.0443	−0.0826	−0.1591
	(−1.46)	(−2.87)***	(−4.36)***
lnRD	0.1577	0.136	0.2873
	(3.09)***	(2.87)***	(5.27)***
lnSC	−0.1673	−0.1685	−0.2093
	(−3.29)***	(−3.58)***	(−4.29)***
lnEX* lnRD		0.0545	
		(5.93)***	
lnIM* lnRD			0.0834
			(5.08)***
Adj. R-square	0.5714	0.5898	0.5853
Hausman	18.51***	20.96***	16.2***
LR	24.99***	30.48***	28.32***

(*), (**) and (***) denote that coefficients are significantly different from zero at a 10, 5 and 1 % level, respectively

attention to improve governance and efficiency of investing. The results further show that interaction of the trade with R&D significantly promotes technical efficiency, suggesting that high-tech industry' R&D improves absorptive capacity and innovation ability and it also conducive to learn management technique and production experience. Comparing with Wu's study (2008), which shows that R&D in industry has poor absorptive capacity, the difference may show there is R&D threshold of technology spillovers and high-tech industry' R&D have attained or surpassed the threshold.

32.4 Discussion and Conclusion

In this paper we presented evidence that technical efficiency of Chinese high-tech industry is relevant to both technology imports and R&D investment. The relationship between them over the period 2000–2009 has been estimated by the econometric model. The results allow us to conclusion that, although exports and imports have no significant effects on technical efficiency, R&D has a positive and significant influence on the technical efficiency of Chinese high-tech industry. And what's more, the interaction of R&D investment and technology imports promotes technical efficiency significantly. It has been shown that R&D investment improves absorptive capacity and innovation ability and it also conducive to learn management technique and production experience in technology imports.

For policy makers, the results of our analysis suggest that adjusting trade structure and encouraging enterprises to increase R&D investment may significantly promote technical efficiency of high-tech industry. That is to say, it is necessary to depend on indigenous R&D to improve technical capacity and form key competition power, and learn management technique and production experience in technology imports, and promote industrial technology upgrading. Persistent R&D investment enhances technical strength and R&D level, so technical absorptive capacity and technical efficiency are further improved. The government should pay more attention to form legal system to protect intellectual property rights, which would effectively stimulate firms to increase R&D investment. In respect of concrete measures, the government could offer subsidies to high-tech firms for research and development on the basis of the difference between individual benefits and social benefits, and promote the conversion of research results by industry-university-research cooperation.

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Chapter 33
The Contribution of VTE to Labor Force Transfer in Rural Area of China

Jing Song and Tong Zhou

Abstract China, a country with a large population in rural area, has to get a lot of professional laborers commanding science and technology, in order to realize the fast growth of economy. This paper holds the point that the method to solve the problem of rural labor force transfer is to improve the comprehensive quality of agricultural workers and farmers, who go to work in city, through developing VTE of them. Feder's two-section model has been taken to verify the contribution degree of VTE to the increase of agricultural economic aggregate. Then Granger causal relation has been adopted to verify the relation between VTE scale and rural labor transfer scale, so that the contribution of VTE to rural labor transfer will be verified, which will urge government to develop VTE by taking it as an institution mean to improve the social and economic position of disadvantaged groups.

Keywords Agricultural workers · Labor force · Rural area · Transfer · VTE

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J. Song (✉)
Education School of Tianjin University, Tianjin 300072, China
e-mail: sjing5555@163.com

T. Zhou
Chizhou University, Chizhou 247000, Anhui, China
e-mail: tongzhou.china.com

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33.1 Introduction

China is a country with a large population in rural area (Li 2010), so it is necessary for it to have a number of professional personnel to develop and spread science and technology so that the fast growth of rural economy may come true (John 2008). The way to have those personnel is to improve all rural laborers' quality through the development of rural vocational and technical education (Ma 2012) (VTE in short).

It is said by certain statistics that the rate of rural laborers, who had received VTE or training, are less than 20 % (Huang et al. 2009). Compared with some developed countries, there is a long road for China to go. About 90 % farmers have received secondary education in Holland, while 12 % graduating from agricultural colleges or universities. Over 70 % of farmers under the age of 35 in West-Germany received rural VTE, and so did about 50 % of farmers over 35 (Wang 2011). Considering the aspect of spreading agricultural technology, there is only one out of over 2 thousand rural laborers on the average doing it, while there will be one among less than 400 in developed countries (Zhong and Hu 2010). On the whole, there is an obvious shortage of science and technical personnel in Chinese rural area.

A research on farmers in China who were born in 1980s shows that 91.7 % of them thought what they need is education, with 69.7 % needing professional knowledge and skills, 47.8 % hoping to enhance their cultural level. It is hold by this research that VTE can meet the demand of rural laborers to improve their knowledge and skill level and it may help the growth of rural economy. In order to verify the hypothesis, it is a must to do a verification and explanation on the relation between VTE and rural laborers' income, in the hope to get a right understanding of VTE's contribution to the growth of rural economy in the term of monetary output.

33.2 VTE and Labor Force Transfer in Rural Area

Essentially, VTE is to make preparation for future job (John 1916). (Dewey) According to International Education Dictionary, VTE refers to all activities with the aim to improve professional proficiency of workers inside and outside schools, including apprentice training, instruction in schools, curriculum training, on-the-job training, and retraining for all and etc. (Page et al. 1980). Premier Wen Jiabao has pointed out in the report, *Developing VTE with Chinese Characteristics*, that it is a must for VTE with Chinese characteristics to work for socialist modernization construction by cultivating workers and skilled personnel of high quality, who may meet the demand of economic and social development, to correspond with socialist market economic system through running schools by multi-subjects while government playing the leading role, to meet demands of all people on VTE for their employment, starting a business, to connect production and social practice closely through the application of flexible training model to build a perfect modern VTE system gradually (Wen 2008). It is formulated in *Vocational Education Law of PRC* in 1996 that VTE system in China consists of vocational school education and vocational training, the former including primary, secondary and higher vocational school education, the latter pre-employment training, apprentice training, doing-a-new-job training, on-the-job training and other kinds of vocational training, which may be classified as primary, medium-level and advanced vocational training (Vocational Education Lae of PRC 2004).

VTE on labor transfer in rural area may be divided into two kinds (Liu 2011): the first one is output training, namely non-agricultural employment training of some farmers, which is conducted by government to transfer surplus laborer force to undertake new jobs; the other one is input training, or the training to enhance rural workers' skill, which is done to make them work better.

If some agricultural laborers turn to take some non-agricultural jobs, they need to learn and get training to master necessary professional knowledge and skills, and safety regulations and etc. With those trainings, they may improve their quality, and their competitive ability will be stronger in labor market. One important project is included in *National Science and Technology Training of New Rural Laborer Program from 2003 to 2010* by agricultural department, which is Training Surplus Rural Labor Force to Take New Jobs Program, with the aim to give instruction and samples for the training, so that their quality and skills to work in city may get improved. It is said in the program that about 3 million would get training from 2003 to 2005, and about 10 million more from 2006 to 2010 (Agriculture Department 2003). Taking the large number of rural laborers to take new jobs and the fast speed into consideration, it is safe to say that VTE has played a very important role in transferring rural labor force.

The input training of rural labor is mainly instructed by many departments of government, which has got enough attention of the Central Committee of CPC and State Department. It has been pointed out in *National Science and Technology Training of New Farmers Program from 2003 to 2010*, issued by agricultural department, that farmers are subject of agricultural production, the important carrier to do agricultural science and technology transfer (Liu and Wang 2011). So their scientific quality will decide the development level of agricultural productivity. It is natural to get the conclusion that giving farmers science and technology training will improve the efficiency of agriculture, increase farmers' income, and make international competitive power of agricultural product become stronger (Agriculture Department 2003).

The research is to adopt Feder's two-section model to verify the contribution degree of VTE to the ascending amount of rural economy, so that the contribution of VTE to rural labor force transfer will be reflected indirectly. Then Granger's causal relation verification model will be taken to find out if there exist causal relation between the VTE scale and the scale of rural labor transfer.

33.3 The Model to Verify the Contribution of VTE to Labor Force Transfer

The two-section model was firstly proposed by Feder, an American economist, in 1983, which has been applied once to estimate the role of export in helping economic growth. Generally speaking, export trade needs to face more intensive competition of international market, while taking part in international competition will lead to some beneficial economical results, such as improving technology innovation, enhancing management efficiency, promoting the development of productivity, realizing economical benefit and etc. The time export trade plays those roles, it will cause strong propulsion efficiency to non-export industry (Feder 1982).

Feder is the first person to use the two-section model, dividing national economy into export section and non-export section. Through bringing the export trade efficiency into model and doing initial measurement and calculation, two points will be got: (1) the spillover effect of export section to non-export section; (2) element productivity difference between export section and non-export section (Jiang et al. 2009). Since it was issued, the model establishment idea has drowned high attention of many experts and scholars, who began to follow Feder's idea to establish relative model to solve various questions (Cohen 2007). This paper, based on Feder's idea, does some revision on Feder's model in accordance with its content and object. The derivation of the model is as following: this paper is based on another two-section production, namely VTE section and Non-VTE section, then:

$$E = f(L_e, K_e)$$

$$N = g(L_n, K_n, E)$$

In the above formula, (E) means output of VTE, while (N) refers to output of Non-VTE, (L) labor and K capital, with subscript showing different section. The second formula implies a hypothesis that output of VTE (E) will cause some influence on the output of Non-VTE (N). Meanwhile, the amount of all labor in one country (L) and the amount of all capital (K) may be expressed by the following formulas:

$$L = L_e + L_n$$

$$K = K_e + K$$

Because it is divided into two sections, the total social product of one country (Y) is the output of one section plus another, so:

$$\mathrm{Y} = \mathrm{E} + \mathrm{N}$$

According to Feder model, there exists the following relation between labor among various sections and the marginal productivity of capital:

$$\frac{f_1}{g_1} = \frac{f_k}{g_k} = 1 + \delta$$

In the equation, f_1 means the marginal output of labor from VTE section, while f_k means the marginal output of capital from VTE section, g_1 the marginal output of labor from Non-VTE section, g_k the marginal output of capital from Non-VTE section, δ the difference of relative marginal productivity between two sections. Combining the above production equation of two sections, the following regression equation may be derived:

$$\frac{dY}{Y} + a\frac{L}{Y} + \frac{dL}{L}\beta + \gamma\frac{dE}{E} \cdot \frac{E}{Y}$$

In it, α means the marginal product of capital from Non-VTE section, while β is labor flexity of product from Non-VTE section, γ the whole effect of VTE on the economical growth of one country, whose relation with δ may be expressed as: $\gamma = \delta/(1+\delta) + g_e$. At the same time, dY/Y, dL/L and dE/E represent the growth rate of total product, labor and product of VTE respectively. E/Y is the proportion of VTE product out of all products, while I/Y is the proportion of domestic investment in GNP, which is also called as the increase of capital stock in one country (dK). In accordance with usual way, (dK) is replaced with domestic investment (I). The parameter in the equation means VTE spillover effect plus element productivity difference effect between two sections, namely one RMB added to VTE leads to γ RMB added in national economy gross. In order to measure and calculate the spillover effect of VTE and the difference effect of relative element productivity, it is assumed to keep the flexibility of products from Non-VTE section unchanged, in line with Feder's way to establish model, then:

$$N = g(L_n, K_n, E) = E^{\theta}(L_n, K_n)$$

θ is the parameter of spillover effect, then the following will be reached:

$$\frac{\partial N}{\partial E} = \theta(\frac{N}{E})$$

With combination and arrangement of the equation, then:

$$\begin{aligned} dY/Y = a(I/Y) + \beta(dL/L) + [\delta/(1+\delta) \\ + \theta(N/E)](dE/E)(E/Y) \end{aligned}$$

After making rearrangement of the equation, then:

$$\begin{aligned} dY/Y = a(I/Y) &+ \beta(dL/L) \\ &+ [\delta/(1+\delta) - \theta](dE/E)(E/Y) + \theta(dE/E) \end{aligned}$$

Table 33.1 Estimation on regression variable modulus

Variable	Modulus	T verification value	Verification value of single end P
Intercept	0.312	0.21	0.81
dL/L	0.101	0.41	0.11
I/Y	0.092	2.32	0.01
(dE/E)(E/Y)	4.571	3.21	0.00
	$R^2 = 0.32$	$F = 7.46$	

The aim of the research is to estimate the contribution of investment in VTE in rural area to the growth of rural economy, with four provinces as samples, namely Liaoning, Anhui, Gansu and Guizhou. Product from VTE (E) is represented by expense from VTE part of government, which is quoted from statistic yearbook on education of every province; investment (I) is quoted from the real budgetary outlay of provincial agricultural department; rural economy (Y) is the result of per capita income of farmers from statistic yearbook of every province multiplying the total rural population; variable I/Y and E/Y is the medium value in the range; while the real growth rate is estimated by regression equation, which means to take the natural logarithm of Y (rural economy gross) as the explained variable, to make regression on time (year) and constant (intercept); the growth rate of VTE output (dE/E) and the increase rate of labor (dL/L) are estimated by regression too. All data quoted in the paper are from 2000 to 2010 (Table 33.1).

Taking the spillover effect of VTE into consideration, according to model principle, input the statistic analysis software after arranging data, then (Table 33.2).

From Table 33.2, when modulus of (dE/dL) is positive, estimated value is positive. Besides, the estimation over the verification level of 5 % is obvious under the condition of single end verification. The estimated value of spillover effect of VTE on the growth of rural economy should be explained as following: if output of VTE (E) increases at the rate of 1 %, with other elements unchanged, the output of Non-VTE section will increase by $\theta\,\%$, and the value of (θ) is 0.429, which is in accordance with relative research.

Table 33.2 Estimation on regression variable modulus

Variable	Modulus	T verification value	Verification value of single end P
Intercept	0.1003	0.18	0.42
dL/L	0.229	0.78	0.18
I/Y	0.997	2.11	0.01
(dE/E)(E/Y)	−4.318	−1.92	0.07
dE/E	0.429	3.12	0.00
	$R^2 = 0.39$	$F = 9.29$	

33.4 Conclusion

VTE has played a lot of important functions in rural labor transfer, to cultivate laborers and develop their quality, to provide qualified members for the society. Government is supposed to develop VTE and take it as an institutionalized means to improve social and economic position of disadvantaged groups. The development of VTE should be an important part of modern social welfare and security.

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Chapter 34
The Design of Master of Engineering's Dynamic Training Mode and Management Informatization System

Wei-tao Liu, Yun-juan Liu and Jian-jun Shen

Abstract As a special education mode of graduate students in the development stage of exploration, the master of engineering education has distinct characteristics as applicability, practicality and so on. Based on the theory of WBS flow chart, this article has made establishment and analysis about the grading flow chart for the master of engineering's training process, constructed the "Quaternity" master of engineering talents dynamic training mode system. This article realized the information platform function of master of engineering's teaching and management system by using Java web technology and My SQL database programming technology.

Keywords Master of engineering · "Quaternity" · System design · Teaching management · Teaching management · WBS flow chart

34.1 Introduction

With the improvement of social development, the dependence and demand of science and technology also increased. At the same time, the innovation ability of ascension and innovative personnel training also rely more and more on the high level education, the graduate student education has become an important one of the

W. Liu (✉) · Y. Liu · J. Shen
Resources and Environmental Engineering Institute, Shandong University of Science and Technology, Qingdao, China
e-mail: wtliu@sdust.edu.cn

Y. Liu
e-mail: liuyunjuan123@163.com

J. Shen
e-mail: shenjianjun11987@163.com

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basic platforms. Master of engineering as a new type of graduate student training mode, to conform to this need, mainly train applied, complex high-level engineering technology and engineering management talent for enterprise (Zhang and Weimin 2011; Mu 2010).

In recent years, with the recruitment of master of engineering's scale and expansion of the quantity, the traditional teaching management system and enclosed static teaching resources didn't suite to the actual demand increasingly and didn't reach the goal of master of engineering education in the new situation, exposed some of the problem to be solved, so the cultivation of the master of engineering's quality was concerned by people increasingly (Chen 2008; Guohua and Gao 2007; Wang et al. 2005). This paper aims to push on the informatization construction of master of engineering's education and promote the cultivation of the master of engineering's quality to raise the overall by way of the design and implementation of the multi-function and interactive tracking mode master of engineering's teaching and management informatization platform.

34.2 Master of Engineering's Training Process Analysis Based on WBS

34.2.1 Master of Engineering's Training Stage Division

Training stages division plays an important part in master of engineering's education development strategy and must be the organic combination of theory and practice. It is the basis of training process WBS resolution (Zhou 2008; Ding 2011; Li and Fan 2010), vertical and horizontal integration and training mode established in the follow-up work. Based on the master of engineering education's life cycle, this study divides the project master training process into five stages (Fig. 34.1), form five grading management system as the enrollment stage, cultivate preparation stage, course stage, paper stage and degree awarded phase.

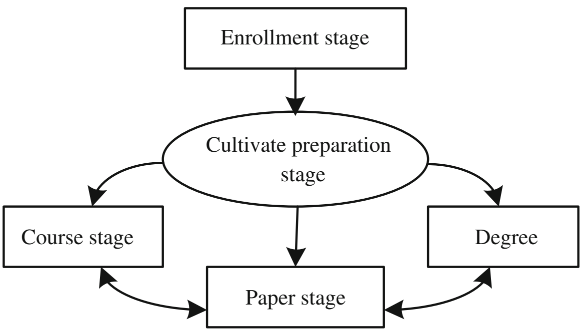


Fig. 34.1 Master of engineering's training stage division

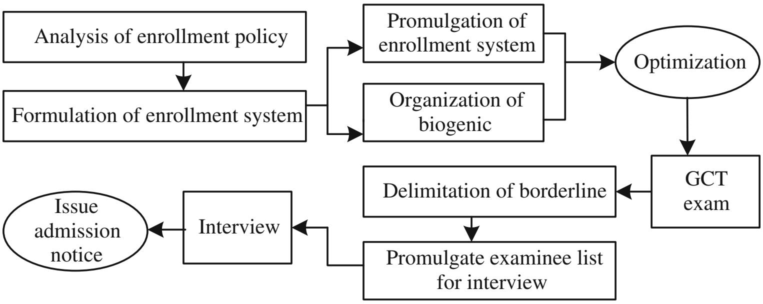


Fig. 34.2 Master of engineering's enrollment process WBS flow chart

34.2.2 Master of Engineering's Training Process Flow

Through the establishment of the master of engineering's education process WBS work breakdown structure can avoid work omissions, and such division combined with progress is intuitive. Take the recruit student stage as an example, establishing the master of engineering's training process WBS flow chart in stages shown as Fig. 34.2. The other phase of the flow can be set up with the same argument.

34.2.3 Survey and Analysis of Master of Engineering's Education Problem

Questionnaire survey is made in writing problems so as to obtain information related to a research method. Based on the factors having effects on the quality of master of engineering training and the comprehensive consideration of various problems the actual situation of master of engineering education may lead to, the researchers developed a questionnaire. The survey respondents is the reading and the graduated project masters of Shandong University of Science and Technology, involving 14 project master field and covering the different length of service period in stages and studies. It can basically reflect master of engineering education problems roundly (Huang and Ma 2009; Cui 2008).

Through the statistical analysis of the recovery of questionnaire, I find that the problems the engineering masters generally arouse mainly in the following respects: contradiction of work and learning extrude; course offering need to be further perfected; master of engineering's book is obsolete, teaching material construction fall behind; teachers to be strengthened, and the double tutors system focuses on the implementation; teaching organization and implementation ways need to be explored continuously.

34.3 Construction of Master of Engineering's "Quaternity" Dynamic Training Mode

The study and exploration of master of engineering training mode is to combine education and system management theory, research how to supervise the master of engineering education according to the objective law of education, to plan, organize, guide, coordinate and control the factors which influence the quality and benefit of master of engineering's education.

Through the whole process of training to master of engineering's WBS analysis in front, combining with the analysis results of the investigation questionnaire, after the first-line workers' interviews of master of engineering's teaching and management, the dynamic training mode of "Quaternity" is formed step by step under the background of engineering practice, taking the training quality of master of engineering as the mainline and the graduates of master of engineering's

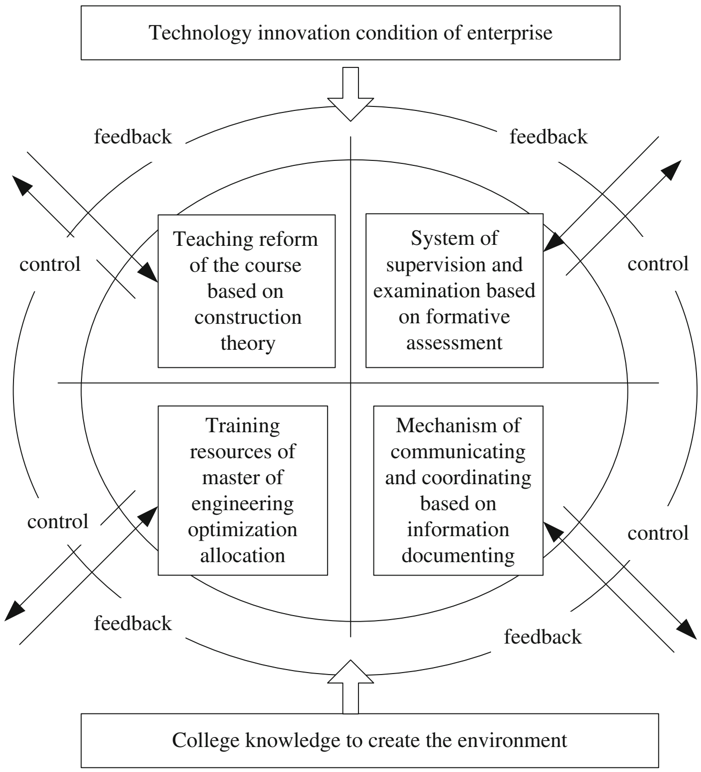


Fig. 34.3 Figure of the "Quaternity" training mode

professional competition as the starting point, taking the course structure, the cultivation resources assessment system, mechanism of communication and coordination for support points (Fig. 34.3).

1. Teaching reform of the course based on the construction theory

In the course teaching of master of engineering, taking the constructivism learning theory as guidance, we should pay special attention to the development of new structure of curriculum content, teaching strategies, multimedia resources of teaching and learning, which is leaner-centered. Standing on the specific teaching link and integrated knowledge framework of master of engineering, each step should lay the foundation and create conditions for shaping of the integrated knowledge framework.

2. System of supervision and examination based on formative assessment

The dynamic of the "Quaternity" training mode is reflected in having healthy feedback mechanism (Fig. 34.4). All interested parties give attention to the whole system from different points of view, the inside and outside is unified and connected closely.

3. Mechanism of communicating and coordinating based on information documenting

The main reason that problems of communication and coordination in training departments of master of engineering exact is the lack of standardization in information transmission. Information documenting just can be a solution to this problem, promote the information transfer and communication without redundancy in different sectors. Meanwhile as having the document records of information, it's not convenient to be consulted and managed in case oversight and repeat, but in favor of well-defined power and responsibility. The crux of the problem existed can be found out timely and the process is so clear that buck-passing between departments can be avoided effectively.

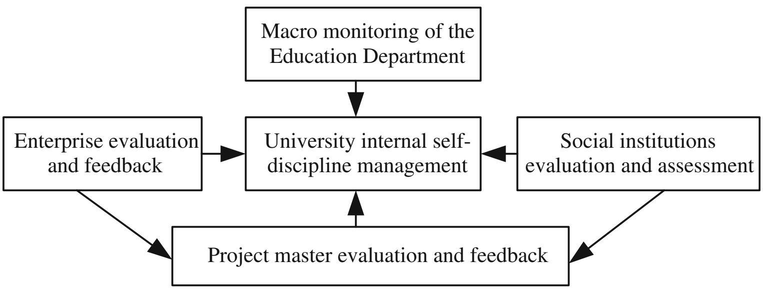


Fig. 34.4 Project master training comprehensive steering feedback mechanism

4. Training resources of master of engineering optimization allocation

Training work of master of engineering hasn't gone hand in hand, each part should develop disproportionately. The emphasis of different parts should be different in different periods. Therefore, emphasis point should be chosen from a variety of possibility and position accurately, thus put the excellent resources into key fields of present development of master of engineering's education.

34.4 The Design of Master of Engineering's Teaching and Management Informatization System

34.4.1 The Significance of Information Construction

It can cultivate the ability of master of engineering to construct the dynamic teaching mode of "Quaternity". Meanwhile, the process of cultivation also asks for the extent of system informatization greatly.

The information construction of teaching and management are defined as combining the functions of education, management and cultivation organically and systematically through computer network and multimedia technology. Differ from traditional significance teaching characteristic, it is inevitable to teaching reform, transformation of management mechanism and renovation of education philosophy for incumbency degree education of enterprise employees who finish school in the shape of "Study without off-the-job". We ever concentrated teach a certain course face-to-face by means of giving a class regularly or on-the-spot teaching, but it makes it difficult for us to organize and manage the students because there is a conflict between study and work for students, super add students work in different places, which makes the teaching quality of master of engineering to a discount. The practice of master of engineering's education urgently required that training units should break through space and time limit, perfect each training link to meet the needs of master of engineering's education and achieve the aim of improving master of engineering's training quality through advancing information construction.

34.4.2 Analysis of the System Function Requirement

It is an important mean for advancing the quality and efficiency of master of engineering's education and main ways for improving decision-making ability and obtaining competitive advantage to the information construction of teaching and management of master of engineering. Information system serves the aim and need of information construction and determines information construction's results to refine and analyze the need of system function.

Table 34.1 Function requirement analysis of master of engineering's information system

Requirement category	Concrete contents
Library service	Provide special account of the electronic resources links within the library for master of engineering
	Provide more usage rights of the professional academic material database
	Provide comprehensive search engine service based on the existing academic resources
	Provide recommendation and introduction of professional books relating to master of engineering
	Provide recommendation booklist of master of engineering's humanistic quality training

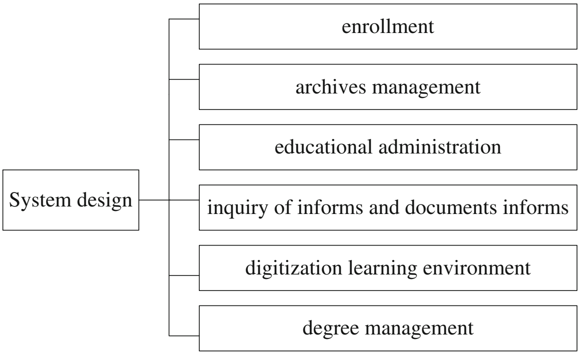
Through aforesaid investigation and establishment of cultivation mode, we classify and summarize the function requirement of library service, teaching service and supervisory service etc. in master of engineering's information system. Take the library service as an example (Table 34.1).

34.4.3 Design of System Framework and Analysis of Function Modules

The system framework is designed according to the training process, requirements of training target and content of function demand of master of engineering. It is comprised of enrollment, archives management, educational administration, inquiry of informs and documents, digitization learning environment and degree management (Fig. 34.5).

Take enrollment as an example to analyze the function modules. The enrollment subsystem includes six modules (Fig. 34.6), among them, the success alumni transcription carry on display the success deeds of graduated masters of engineering, in order to encourage the excellent incumbency technicians taking the

Fig. 34.5 Design of system framework



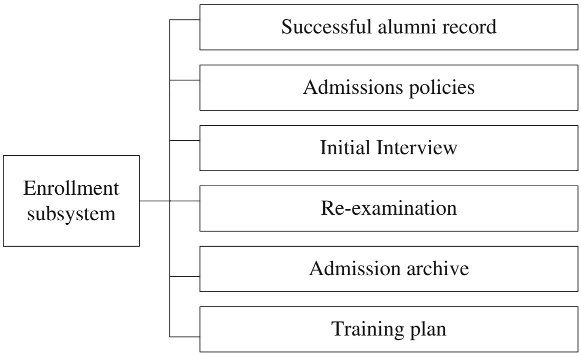


Fig. 34.6 Functional block diagram of enrollment subsystem

entrance exam of master of engineering education actively to expand career path through the continuation advanced studies to improve the quality of enrollment.

34.4.4 Design of System Operation Authority

This system supports multi-user online access, so user authority must be set and defined. As Fig. 34.7 shows, different rank users have different access. Only giving the backstage users necessary authority supporting, restricting the management scope of users can it realize efficient management of teaching and management system, provide the humanized service for masters of engineering.

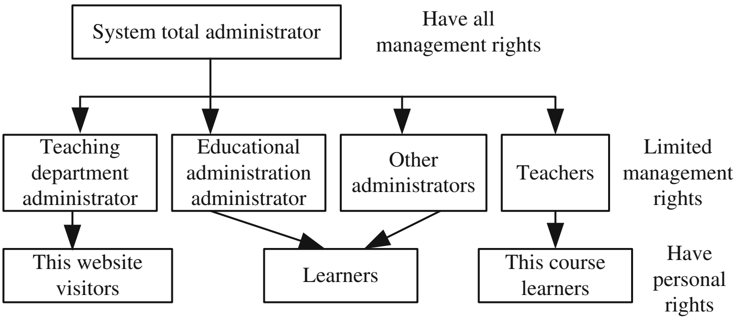


Fig. 34.7 Distribution of system management rights

34.5 Development and Application of Safety Management Information Platform Based on ASP.NET

34.5.1 Development of Information Platform (Shixuan and Wang 2002; Wang and Zhu 2004; Shang 2004; Gong 2000; Robinson and Nagel 2005)

ASP.NET is a unified Web development platform which is compiled and based on .NET. Many languages can be used compatibly with .NET to create application, such as Visual Basic.NET, C# and JScript.NET, etc.

This system development chooses Java as a programming language and takes MYSQL as the background database system based on the B/S structure mode, realizing interactive operation of webpage and background database by using the Java web technology, setting up the dual connection between the client and Web server to gear up the realization of system functions.

It needs to configurate the running and development environment to carry on Java web application development. This system chooses the Tomcat5.5 environment to develop and debug after comparison. Because the Java used in Java web needs to be compiled before deployment, so it need to use JDK1.5. After installation of JDK, start Tomcat5.5 installation program. Use the account number to set up to log on to the Tomcat background management environment which can publish web program or create other web resources.

34.5.2 Application of Information Platform

After running the start command of database and management system, the system will be activated to the landing interface automatically. After landing according to the operation authority, the system can be used normally for links of master of engineering training chain.

System makes different reaction based on users' right, masters of engineering enter the appropriate permissions within the page after identity authentication, the users use management pages for the specific operation. The system home page sets of six functional menu, in order to achieve specific functions of the system such as the enrollment, electronic file management, educational administration management, document information, the digital learning environment, degree management.

The information construction of master of engineering education architectures a bridge between resource sharing and information exchange and broke through the constraints of time in teaching and management methods, and it's also a revolution in educational philosophy. The development and application of information platform has changed the content and manner of dissemination of knowledge, and teaching reform shows a new situation.

34.6 Conclusion

For the lack of resource sharing and information exchange in the culture of the master of engineering, limitation to time, space and region in the teaching and management ways, the obvious contradiction between work and learning and outdated curriculum, this article establishes the master of engineering's teaching and management informatization system through the establishment of the "Quaternity" master of engineering's dynamic training mode and the use of computer programming and network technology, so as to realize the systematic, information technology, and efficient of the master of engineering's management.

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Chapter 35
The Incentive Model of People-Oriented Innovative Organization: Based on Dill's Comprehensive Incentive Theory

Yi Liu and Heng-ying Li

Abstract People-oriented innovative organization is a kind of typical humanistic learning organization form and the trend of future organization. So, establish an effective incentive mechanism in order to improve the performance of the organization become particularly important. While the traditional incentive theory often lacks of specificity and pertinence, this article based on the characteristics of the people-oriented innovative organization, a theoretical model of Dill, combining humanistic thought and exogenous incentive classification related theory, construct a more suitable model for people-oriented innovative organization. At last, this article puts forward the incentive measures based on the new model.

Keywords Dill's comprehensive incentive theory · Innovative organization · New model · People-oriented

35.1 Introduction

With the deepening of economic globalization and the enterprise the increasingly intense competition, in recent years, more and more enterprises are not satisfied with the quality and efficiency of the pursuit. Many enterprises realize innovation in enterprise play an important role, and the innovation on the prominent place, and become innovative organization. Man is the source of creativity and soul, so humanistic thought must permeate the innovative organization of organization culture, form is with the person this innovative organization. Effective incentive mechanisms directly contribute to the improvement of organizational performance, so to seek an effective incentive mechanism is especially important.

Y. Liu (✉) · H. Li
Department of Economic and Management, Taiyuan University of Science and Technology, Taiyuan, China
e-mail: maimupiaopiao@126.com

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35.2 The Concept and Characteristics of People-Oriented Innovative Organization

The so-called innovative organization, it is to point to the innovation of the organization ability and the innovation consciousness is stronger, continuously technology innovation, innovation and management innovation and so on a series of innovative activities of the organization. Peter (1987) said: an innovative organization is the innovation spirit institutionalization and create a habit of innovation. The people-oriented innovative organization is to show people in the leading position, and give full play to people's enthusiasm and creativity of the organization, and it can let employees for self-management, self-study, play internal to self-potential and achieve personal and business grow together. It has the following characteristics (Christiansen 2000).

35.2.1 Continuous Learning and Innovation

An innovative organization is in essence a kind of typical learning organization. Innovative organization staff are engaged in different from general physical labor, not simple mechanical repetitive (Saura Diaz and Gomez-Mejia 1997), but rather make full use of their knowledge and talent and inspiration to solve problems and make innovative achievements. Learning is the foundation of the innovation ability, the organization should set up the idea of learning, and emphasizing the individual learning at the same time, an innovative organization pays more attention to the learning organization level. Personal knowledge should be shared by the members of the organization more, in order to improve the organization's creativity.

35.2.2 Everyone is Equal, Trust Each Other

Humanistic thought requirements should be concerned about enterprise every employee, the organization members all equal. Everyone is equal in information and knowledge acquisition, possession, anyone can not have privilege (Willson 1994). Not for information or knowledge within the organization get monopoly position advantage, otherwise it will be difficult to achieve in the organization flow of knowledge and share. Trust each other refers to each group members are willing to each other's heart communication and knowledge and information sharing, everyone have the right to speak (Gupta and Singhal 1993). Everyone is equal, trust each other embodies a kind of full of humane care organization atmosphere.

35.2.3 Staff Autonomy is Strong, Strong Sense of Achievement

It highlights the man's status and uniqueness, weakened the traditional enterprise to command and control primarily management method, the return to the attention of the human nature. Employees have the independent ability, and the stronger ability, independent engaged in an activity of the stronger consciousness. Innovative employees usually have the high demand; often pay more attention to their own value realization (Helton 1998). They are not content with passively complete general affairs, but try to pursue perfect result, they expect their work more meaningful and contribution to the enterprise, and strong hope their achievements can get organized and social acceptance.

35.2.4 Positive Internal Communication and Cooperation

It stressed that the organization and staff to common development. Effective communication between different members, this is the sharing of information to the most basic requirements. The inspiration of innovation and spark a lot is come from different members of the collision between thoughts. Good communication embodies in the whole team members to become close friends, can quickly and effectively share ideas and emotions, so that the organization competitive ability and ability to adapt can improve, organization and staff to achieve common development, and the staff in the realization of personal vision in the process also to achieve the organizational goals.

On the basis of analysis of the characteristics of the People-oriented innovative organization, this paper will seek a suitable for the characteristics of the innovative organization incentive theory (Little 1998). The existing incentive theory can be divided into the process theory, behavioral theory and comprehensive incentive theory, and so on. The model is based on Dill's comprehensive incentive theory.

35.3 The Summarizes on the Dill's Comprehensive Incentive Theory and the Establishment of New Model

35.3.1 The Summarizes on Dill's Comprehensive Incentive Theory

The Dill's comprehensive incentive model first published in 1981, by American organization behaviorists W. Dill (Guan and Wang 2002). It is based on Valence Instrumentality Expectancy (VIE) theory, joined the internal and external incentive theory and adopted a mathematical formula of expressions. W. Dill builds this model is the starting point of the total incentive levels should be the intrinsic motivation level and extrinsic motivation level adding together. He summarized the formula as follows:

$$M = V_{it} + E_{ia}V_{ia} + E_{ia}\sum_{j=1}^{n} E_{ej}V_{ej} \tag{35.1}$$

In the formula (35.1), i mean intrinsic, e mean extrinsic, t mean task, a mean achieve, j mean all kinds of external incentives, M mean total incentive levels (Huang 2001).

1. V_{it}. It means the valence the task brings itself.
2. $E_{ia}V_{ia}$. E_{ia} and V_{ia} mean the expectancy and valence to finish the task. Their combined effects, reflecting the excitation force generated when the task is completed.
3. $E_{ia}\sum_{j=1}^{n} E_{ej}V_{ej}$. E_{ej} mean the expectations of a number of external incentives and V_{ej} mean the valence of external incentives express the all possible external incentives. E_{ia} is the expectations of the possibility of the task is completed. E_{ej} means that could further lead to some kind of subjective expectations of extrinsic motivation to complete the task and this is a sufficient condition for a variety of extrinsic motivation can play a role. E_{ia} is a result of the first-order expectations, and E_{ej} is the result of second-order expectations. The results of second-order is a personal hope to achieve the end result of an action, first-order result is that the initial results only to be met in order to achieve second-order results. Therefore, the first order result is that the tools and means to achieve the second-order results. The two together can be fully expressed external incentives.

35.3.2 New Model and the Basic Theory

The survey of American scholar Mary-han reflect the different extent for the knowledge workers of different incentives, accounting for 7.07 % of money wealth; the achievement of business accounted for 28.69 %; accounted for 30.51 % of job autonomy; accounted for 33.74 % of individual growth. It can be seen that the innovative organization employees pay more attention to the achievements, the free work environment and individual growth, while the material of money incentives (Yan 2010).

It can be seen from the above analysis of the incentive model of W. Dill. It is the simple addition of a number of external incentives. In this paper, we consider the actual characteristics of innovative people-oriented organization and appropriate based on the theory, specifically make the following changes to the formula.

$$M = V_{it} + E_{ia}V_{ia} + E_{ia}\sum_{j=1}^{n}(E_{mj}V_{mj} + E_{sj}V_{sj}) \tag{35.2}$$

In the formula (35.2), m represents the motivating factor of the materiality and the s represents the motivating factor of the Social emotional social emotion. The meaning of other letters with the same meaning as expressed in the formula (35.1). The new model change $E_{ej}V_{ej}$ to $E_{mj}V_{mj}$ plus $E_{sj}V_{sj}$. The reason why changed the external demand to the two parts is that the external incentives from the two parts need, as part of the material needs and the other part of the social emotional needs (Chen and Yu 2004).

1. Material needs

It can lead to material incentive ($E_{mj}V_{mj}$). This type usually refers to wages, bonuses, and various benefits of material resources to meet the needs. Such resources is an objective, and can sense and measurement. At the same time, they are expendable and higher cost. There is another feature of material resources, that is, they are versatile, refers to, not only specific people. The material incentives which have some positive effect incentive is necessary, but must recognize its limitations. Especially in the innovative organization, the material incentives in many cases have faded.

2. Social emotional needs

It can lead to social emotional incentive ($E_{sj}V_{sj}$). The needs star from satisfying people's spiritual needs, to exert the necessary influence on human psychology, resulting in the excitation force. Influence people's behaviors often use trust, recognition, praise, respect, honor, friendship, warmth, and special close relationship between the social feelings of the resources to meet and these needs is higher than material needs. In People-oriented innovative organization (Li 2006), people desire for reciprocity, mutual cooperation, positive and harmonious relationships, the care of colleagues and superiors, mutual respect, so employees tend to have higher level of demand. Therefore, we should pay special attention to the social emotional needs. This is the reason to make model modifications

35.4 Countermeasures to be Taken Based on the New Model

The new model (35.2) contains four types of potency variables (V_{it}, V_{ia}, V_{mj}, V_{sj}) and three types of expectations variables (E_{ia}, E_{mj}, E_{sj}). Since the relationship between them is additive or multiplying, so the total excitation level M is an increasing function of these seven variables. This means that you want to increase the total level of incentives, should seek to increase these variables, respectively.

In addition, what should be noted is that although this model has the form of a formula, but in fact no quantitative analysis and calculation functions, because we have so far not precise quantitative and reliable measurement of these seven factors. However, this does not mean this formula there is no practical value; on the contrary, it can give managers a systematic, coherent analysis of routes and the thinking process in order to identify effective strategies to improve incentives. Now combined with the characteristics of People-oriented innovative organization; respectively, to explore how to improve these seven variables, thereby increasing the level of the total incentive of M.

35.4.1 How to Improve V_{it}

Its essence is how to make tasks more attractive. Make mission objectives to better meet the individual needs. You can take the work rotation and job enlargement and enrichment. Minimize and avoid the ambiguous phenomenon of tasks, so that employees clearly aware of their tasks, the nature of work, work content and responsibilities (Locke 1984). Provide more opportunity to get achievements. This can improve the attractiveness of the work, to allow trade unions to be more passionate to work.

35.4.2 How to Improve V_{ia}

This refers to the achievements made when work is completed there should be more attractive. The innovative organization employees a sense of accomplishment is very strong, to explain clearly the importance of his are engaged in the task. Make employees aware of the significance of their work completed for the organization and society. Also note that the tasks assigned to have a certain integrity, cannot be separated too small.

35.4.3 How to Improve V_{mj}

This is to improve the attractiveness of the material incentive of the external incentives. Since each person's hobbies and needs are different, the reward is not the same potency. Should use a variety of investigative techniques and do the right remedy according to the actual needs of each person.

35.4.4 How to Improve V_{sj}

The employees of People-oriented innovative organization pay more attention to the realization of their own values. So this point for organization is particularly important, the well will have a greater incentive effect, done also have a negative effect. Establish good channels of communication in the organization, to create an organizational climate which has mutual trust, mutual respect and mutual cooperation (Hall and Moss 1998). Appropriate to increase the opportunities to interact with others at work. Echelon personnel training mechanism, focus on the timely promotion of employees, and enhance the enthusiasm of the staff. In addition, leaders should pay attention to the care and counseling subordinates, but also to improve the staff's sense of honor.

35.4.5 How to Improve E_{ia}

This is to improve the expectations of employees to complete the task (Dweck and Leggett 1988). The staff in innovative organization require comfortable work environment, so the first to provide workers with a good environment to complete the task, helping them to draw inspiration and innovative. Second, organizations should plan for staff training in knowledge and ability, to improve their ability to complete tasks. Again, we should pay attention to the work results of timely feedback, so that prompt corrective actions, to ensure the successful completion of the task.

35.4.6 How to Improve E_{mj}

This is to improve the expectations of extrinsic rewards. Company should develop a strict wage and incentive mechanisms. According to the principles of performance paid workers on the correlation between compensation and performance awareness and sense of fairness, thereby increasing the expectations of reward.

35.4.7 How to Improve E_{sj}

This is to increase the feelings of the external social reward expectations. In addition to efforts to shape the people-oriented organizational culture, the establishment of a positive and harmonious atmosphere of the organization, the role of leadership in the organization is particularly important (Vande Walle 2001). Leaders should be treated equally to employees, credible, and timely recognition and higher honor award on the staff.

35.5 Conclusion

This paper establishes a new model based on the analysis of the characteristics of People-oriented innovative organization and the theory of external incentives. Incentives to take based on the new model, to better reflect the specificity and focus in the People-oriented innovative organization. This paper argues that it should be focused on increasing extrinsic motivation for the social emotional needs. That will be able to achieve a better incentive effect, and significantly improve organizational performance.

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Chapter 36
The Option-Pricing Model of Wind Power Investment Projects Included Value-Leaking Losses

Hao Lu and Peng Cheng

Abstract Compared with conventional generation, the investment in the wind power faces more risks. In this paper, we considered the value leaking losses in the wind power project which stem from the cash flow and convenience value ratio proposed a unique approach based on the method presented by Copeland and Antikarov, and illustrates the approach with an investment of the wind power project example.

Keywords Binomial decision tree · Real option · Wind power · Value-leaking losses

36.1 Introduction

Starting essentially from scratch just a few years ago, China has been the country with most installed wind power capacity. In the past year, China has more than 80 wind turbine manufacturers, four of which are among the top 10 globally by market share. China's officials have spoken off the record of targets that will reach 150 GW by 2015 and 250 GW by 2020 (Dalu and Yongwang 2011). Compared with conventional generation, the investment in the wind power faces more risks, such as the fluctuation of electricity prices, high operation costs, the power transmission bottlenecks and uncertainty of investment policies (Allcott 2011).

Considering the high-risk characteristics, the traditional discounted cash flow method is hardly used for calculating the value of the wind power projects for the

H. Lu (✉)
School of Science, Chongqing Jiaotong University, Chongqing, China
e-mail: 11693660@qq.com

P. Cheng
Logistic Engineering University, Chongqing, China

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reason that it would not take the value of managerial flexibility into account, which was inherent in project. Compared with discounted cash flow, the real option valuation techniques would be suit for the risky wind power projects because the real options derived from managerial flexibility (Brandao et al. 2005; Smith and von Winterfeldt 2004; Amram and Kulatilaka 1998; Orinai and Sobrero 2008; Smith and Nau 1995).

In this paper, we considered the value leaking losses in the wind power project which stem from the cash flow and convenience value ratio, proposed a unique approach based on the method presented by Copeland and Antikarov.

The rest of the paper is organized as follows. Section 36.2 introduced a decision tree approach to the real-option problem discussed by Copeland and Tufano. Section 36.3 provides an extension of this approach to the wind power project in which the value leaking losses have been considered. This approach is illustrated in Sect. 36.4 with a numerical example. In Sect. 36.5 we summarize this approach.

36.2 The Basic Option-Pricing Model

The venture capital firm plan to invest to a wind power project. Investment validity can be divided to N stages which cost Δt, the investment in the t stage is I_t. The initial value is V. We assume that the asset value will increase to Vu with probability p at the end of each stage, and will decrease to Vd with probability $1-p$, where $u = e^{\sigma\sqrt{\Delta t}}$ is greater than 1 reflecting the growth ratio of the project value, $d = 1/u$ is smaller than 1 reflecting the reduction ratio of the project value, and $p = \frac{e^{rt}-d}{u-d}$ (John et al. 2008) is the risk neutral probability which can be used to calculate the expected value when the future payoffs had been known, and r is the risk free rate which can be used to discount the future payoffs. When we continued to apply the same percentage changes to the values of the wind power project, this method could be extended to multiple stages. When stage $t = i$, the value can be shown in Eq. (36.1):

$$V_{ij} = Vu^{j-1}d^{i-j} \tag{36.1}$$

Here $j = 1, 2, \cdots, i, i = 1, 2, \cdots, N$.

According to Marketed asset disclaimer proposed by Copeland and Antikarov (Copeland and Tufano 2004), the present value of the project without options is the best unbiased estimator of the market value of the project. Under this assumption, the value of the project without options serves as the underlying asset in the replicating portfolio. So we can price the options with the traditional option pricing methods proposed by Myers if the changes of the project value exclude options are assumed to vary over stages follows a random walk stochastic process, such as geometric Brownian motion. This decision analysis approach to valuation can be described as follows:

Step 1: Without regard to managerial flexibility, the expected present value of the project can be calculated by the traditional discounted cash flow method. The expected present value of the project in each stage is:

$$\bar{V}_i = \sum_{t=i}^{n} \frac{C_t}{(1+\mu)^{t-i}} \tag{36.2}$$

where μ is the risk adjusted discount rate,and $C_t$is the cash flows in each stage.

Step 2: To analyse the risk of the wind power projects, the volatility σ can be calculated by the Monte Carlo simulation (Esber and Baier 2010) of the project future earnings.

Step 3: Given the initial expected project value and the project volatility determined as indicated above, a binomial tree can be constructed to model the stochastic process for project value.

Step 4: Identifying and pricing those real options in the project. Beginning at the last stage, we calculate the value of the options, and mark node the maximum of the options value and the investment in the stage. Then the value of the options can be obtained by decision tree in which each node can be calculated by the replicating portfolio. At last, the expected present value included the managerial flexibility can be obtained in the initial stage.

The basic option-pricing model is not only intuitively appealing but also computationally transparent. The real options in the project can simply be modeled with decision nodes in the tree. However, value-leaking losses are the common phenomenon in real assets pricing. Considering value leaking losses, we modified the basic option-pricing model, try to construct a unique binomial tree not only by the expected present value in each stage and in each statu, but also value-leaking loss, and use option-pricing method to solve the binomial tree.

36.3 The Modified Option Pricing Model Included Leaking Losses

In fact, value-leaking losses are the common phenomenon in real assets pricing, which stem from the cash flow and convenience value ratio. In the modified option-pricing model, value-leaking losses can be set a part of calibration assets, and the proportion can be changed by stage because the management of the risky project would be a multistage decision process.

To calculate the value-leaking loss, we introduce the rate $k_i = C_i/\bar{V}_i$ into the option-pricing model. On one hand, the rate k_i would be changed by stage i because the proportion can be changed by stage, on the other hand, the rate k_i

would not be changed by statu j, because value-leaking losses is set a part of calibration assets. So the value-leaking loss in the stage i and the statu j can be defined as $C_{ij} = k_i V_{ij}$.

In the modified option-pricing model, the first two steps are identical to the method proposed by Copeland and Antikarov. However, we provide an alternative solution methodology to reflect value-leaking loss in the third step. The asset price binomial tree would be constructed not only by the expected present value in each stage and in each statu, but also value-leaking loss. For completeness, we interpret the modifications of the third step in detail.

Firstly, calculating the value of the project deducted the leakage V^1_{ij} :

$$\begin{aligned} V_i^{1u} &= u(V_{i-1} - C_{i-1}) \\ V_i^{1d} &= d(V_{i-1} - C_{i-1}) \end{aligned} \tag{36.3}$$

In Eq. (36.3), the symbols u correspond to the value up state of the projects and d correspond to the value down state of projects. V_{i-1} is the value of the project in previous stage. $C_{i-1} = k_{i-1}V_{i-1}$ is the value-leaking loss in previous stage, which reduces the project value in the subsequent stages. Specially, $k_0 = 0$, because when $i = 0$, the project has not yet been initiated, and there are no value-leaking losses in the initial period.

Secondly, calculating the expected present value of the project deducted the leakage V^2_{ij} :

$$V^2_{ij} = \frac{V^1_{ij}}{(1+r)^i} \tag{36.4}$$

Thirdly, calculating the expected present value of the value-leaking loss in each stage and in each statu:

$$C^1_{ij} = k_i V^2_{ij} \tag{36.5}$$

Lastly, calculating the expected present value of the project in each stage and in each statu V_{ij} :

$$V_i = V^2_i + \sum_{m=1}^{i} C^1_m \tag{36.6}$$

Thus, Eq. (36.6) can provide us the value of every node in each chance of the binomial tree. Because the risk neutral probabilities have been used, the present value of the wind power project at the initial stage could be getted by the means of payoffs discounted at the risk free rate.

36.4 A Numerical Example

The modified option-pricing model can be illustrated by solving for the value of an wind power production project. The example project has estimated 29 MW per year, the wind power price starts at \$10 per megawatts (MW) and grows at 11 % per year over its 4 year operating life. In this example we assume the risk adjusted discount rate is 10 % each year, the risk free rate is 5 % each year and the standard deviation has estimated 35 %. The initial investment is \$9 million.

At the end of the third year, the project can be selled by salvage of \$4 million. There is also a \$1 million per year fixed cost that is not shown in the Table 36.1. We firstly discuss the expected value of the future cash flows showed in Table 36.1. All values are in ten thousand of dollars.

In the initial Year, the present value of the expected cash flows is \$8.7 million, which was calculated by the risk adjusted discount rate 10 % each year. According to the assumption proposed by Copeland and Antikarov, this can be served as the best estimate of the current market value of the wind power project excluded options. Because the up-front investment is \$9 million, the project's NPV is −0.3 million.

In this example, we assume $\Delta t = 1$, incorporate the values of u, d, and the risk neutral probability p into the model, and calculate by the formulas defined previously. So we can get $u = 1.42$, $d = 0.71$ and $p = 0.48$.

Because the other assumption is that these returns are normally distributed, the project values are lognormally distributed and can be modeled as a Geometric Brownian Motion with constant volatility. The binomial approximation to the GBM process may be modeled by binomial tree. To construct the binomial tree, the following parameters are necessary: project value in the initial stage, the values of u and d, the risk neutral probability, the risk free rate of return, the volatility reflecting the risks of the project, and the project cash flow payout ratios calculated by the formulas defined previously. The value of the wind power project could be getted by the usual dynamic programming approaches, and the discount rate of the expected cash flows adopt the risk free rate. Figure 36.1 shows the binomial tree of value of project excluded options, and the asset price in each stage and in each statu.

According to the real option theory, the modified binomial tree can be used to price the real options because it represents the underlying asset. In this case, investors can abandon the wind power project in the third year for price of \$4 million. The investor might need the abandon option if it is averse to risks in the

Table 36.1 Cash flows and ratio for the wind power project

Years	0	1	2	3	4
Net cash flows		222	257	297	340
PV of cash flows	870	957	808	606	340
K = FCF/PV		0.232	0.318	0.49	1

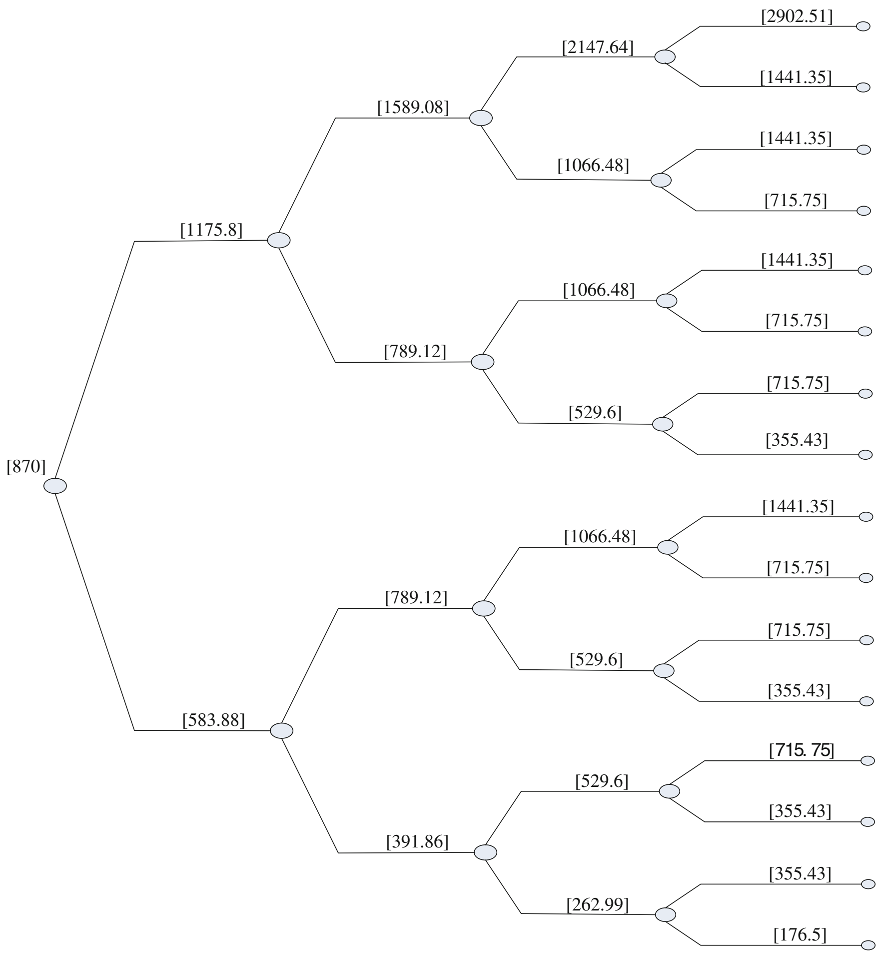

Fig. 36.1 Binomial tree of the project value excluded options

following stages. According to the option-pricing model proposed by Copeland and Antikarov, the value of the project including the abandon option can be evaluated by simply inserting a decision node in Year 3. In the end of the third year, the value of the project including the abandon option is:

$$VO_{3j} = \max(V_{3j}, 400/(1 + 0.05)^3)$$

And the value of the project including the abandon option in the end of the second year and initial year also can be computed using the same risk neutral. The expected present value of the project considering flexibility would be \$8.81 million. However, the required up-front investment is \$9 million, so the project's NPV

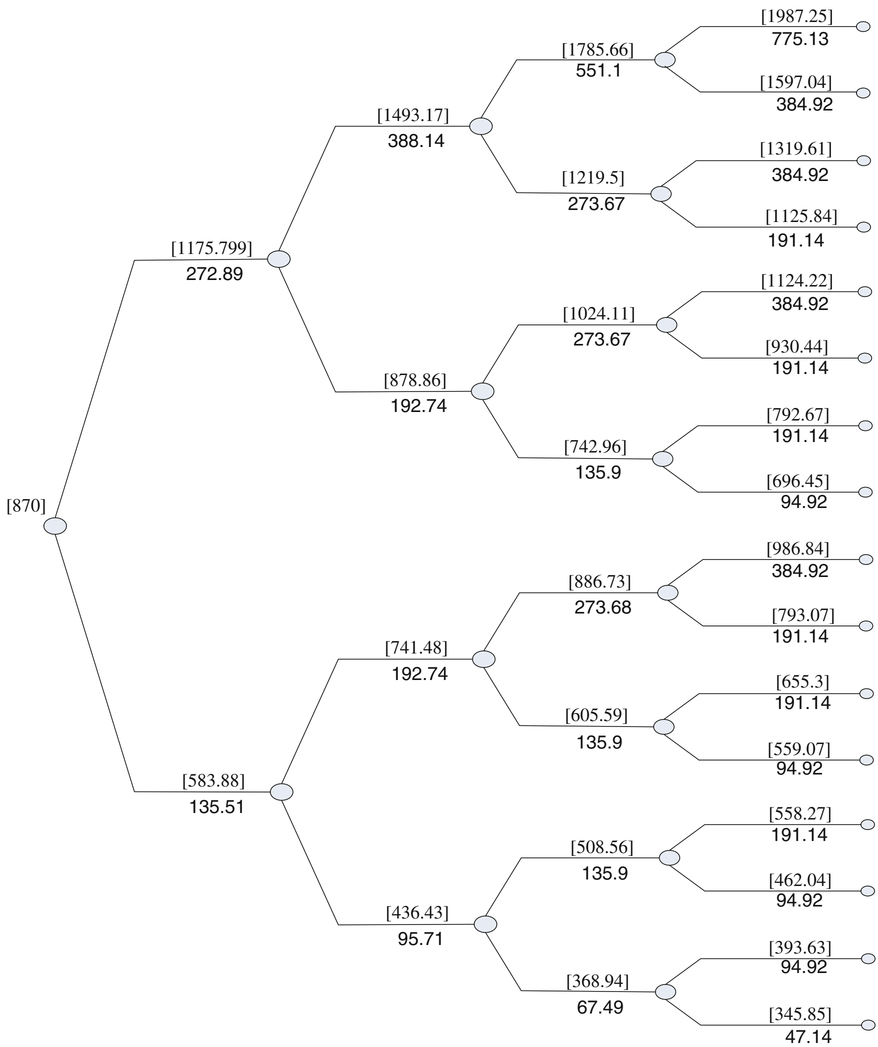

Fig. 36.2 Value of project with option to divest

is −0.19 million. The conclusion is that the wind power project would not be worth to invest.

According to the modified option-pricing model proposed by us, the binomial tree can be used to price the real options because it represents the underlying asset. The construction of the tree and the process of calculating the present value can be illustrated in Fig. 36.2. In addition, suppose investors have the right to abandon the project in the fourth year of its life. The firm might specifically want this option if it is averse to risks later in the project life. Given the binomial tree representation, increased to $10.09 million, so the project's NPV is 1.09 million. The conclusion is that the wind power project would be worth to invest. Compared with the CA approach, our method is more reasonable for a wind power project.

36.5 Conclusion

When discussing the investments in real assets, Discounted cash flow method maybe the most widely used approach for the valuation of projects. However, it is not fit for the wind power projects because Discounted cash flow method is hardly account for managerial flexibility inherent in the projects. In this article, our discussion expanded on the approach presented originally by Copeland and Antikarov, modified the real option pricing model and set up a unique binomial decision tree including the value leaking losses in the wind power project. Firstly, we outlined a decision tree approach to the real-option problem discussed by Copeland and Tufano, then provided an extension of this approach to the wind power project in which the value leaking losses has been considered. This approach has been illustrated with a numerical example. Compared with the basic option pricing model, our approach discussed the value leaking losses in the wind power project which stem from the cash flow and convenience value ratio.

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Chapter 37
The Research of Key Factors in Higher Agricultural Education Resource Management

Li Zhang, Jia-song Ren, Hong-yan Xie and Ze-guo Qiu

Abstract Studying research results at home and abroad, we got the initial set of indicators about the impact factor of higher agricultural education resource management. On the basis of previous work, we designed and released group expert questionnaires. Using the gray statistical principle, we made whitening function data processing and grey statistical calculation on the importance degree of the recovered questionnaires in order to determinate the key influent factors of higher agricultural education resources management.

Keywords Agricultural education · Grey statistics · Higher education · Resources influent factors

As an important component of Chinese higher education, higher agricultural education is the important base of training high agricultural talents and scientific researching. In recent years, higher agricultural education achieved the span of reform and development which made positive affect and promoting role on the social economy of our country especially the development of rural economy (Zhang 2008a). Therefore, speeding up to establish the agricultural higher education resource allocation and management mechanism have important theory significance and practical significance to effectively carry on the Twelfth Five-Year Plan development strategy, promote local economy smoothly and healthy develop.

From a microcosmic perspective of resource management, through a lot of investigation and document study, we comprehensive research results both at home and abroad and agriculture higher education resources management system

L. Zhang (✉) · H. Xie · Z. Qiu
Harbin University of Commerce, Harbin, Helongjiang, People's Republic of China
e-mail: zhangli007008@126.com

J. Ren
School of Economics and Business Administration in Heilongjiang University, Harbin, Heilongjiang, People's Republic of China

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of our country and give the initial set of indicators of higher agricultural education resources management influence factor. Using the gray statistical principle screening indicator set of key factors in order to lay a foundation to higher agricultural education resource management evaluation index system.

37.1 Higher Agricultural Education and Higher Agricultural Education Resources

37.1.1 Higher Agricultural Education

There are still many differences on the concept of higher agricultural education in domestic scholars. The focus of debate is on the teaching level of higher agricultural education and the scope definition of interdisciplinary and there is already basically consensus on higher agricultural education.

Zhan-zhong Jin thought agricultural education is a kind of social activity to cultivate talent of agriculture, with narrow and broad sense (Jin 2002). Defining higher agricultural education on professional courses, Yan Zhou thought agricultural education was a higher education branch which was engaged in agriculture or agricultural science education, which can be called agricultural education (Zhou 2008).

The article thinks higher agricultural education is an important part of education system, a characteristic branch of higher education and a professional educational activity who engaged in agriculture and related industries in the general education foundation. It includes not only all levels of education in higher agricultural universities but also other field of education related to agricultural science and technology.

37.1.2 Higher Agricultural Education Resources

At present, the literature on definition of higher agricultural education resources concepts is relatively scarce. Gao and Hao (2008) thought, generalized education resources refers to a kind of education economy conditions and a combination of all manpower and material resources, financial resources and information about education. The narrow sense of educational resources refers to financial resources. Luo (2006) regarded higher education resources as a variety of resources comprehensive that is applicable to the activities of higher education institutions and helpful to enhance the education of human capital value. On higher education resources specific content, Ban (2007) thought the resources of higher education includes the necessary hardware facilities provided by the higher education institutions on education, scientific research and social service activities. While, Fang and Wang (2009) distinguished higher agricultural education resources into tangible resources and intangible resources from the aspect of the nature resources.

To sum up, higher agricultural education resources is a collection of internal and external environment that higher agricultural educations rely on. An integration system that each elements interact, mutually influent and certainly effect society, which is made up by the stuff, funds, infrastructure, management system and the teaching and research output.

37.2 The Initial Set of Indicators of Higher Agricultural Education Resources Management Influence Factor

With the internal and external environment of higher agricultural education in our country, with the higher agricultural education research literature content on higher education by the scholars of our country (Qiu and Wen 2010; Zhang et al. 2010; Yang 2008; Zhang 2008b; Yang 2005; Wang et al. 2006; Shen 2009). This study collected the initial set of indicators of China higher agricultural education resources management influence, as the index and factors were shown in columns in Table 37.1.

The initial set of indicators has 38 major effect factors, which reflects the related information that impacts higher agricultural education resources management in different extent. We hope that the number of key factors is less and the evaluation information is more. According to the initial set of indicators, we designed and issued 90 copies of expert group questionnaires, recovering 77 valid questionnaires. We collected and sorted out the information of the recovered questionnaire. Due to the length of the article, the specific process was not written.

37.3 Methods and Steps to Screen the Key Affecting Factors by Grey Statistical Principle

37.3.1 Structure Grey Whiting Function

According to expert advice, we set the important factors of higher agricultural education resources management into three gray types (Xu 2002): high, medium and low. Construct the various grades of grey whiting function, such as formulas (37.1), (37.2), (37.3). Set $f_k(ij)$ as the j affecting factor with i degree of importance for whitening function value. K is grey type number, $K = 1, 2, 3$. d_{ij} is the j affecting factor with i degree of importance for score. The calculation formula of $f_k(ij)$ are (37.1), (37.2), (37.3), $i = 1, 2, \cdots 7$, $j = 1, 2, \cdots 46$.

Table 37.1 Grey statistic analysis and the availability comprehensive selection of the degree of importance on factors influencing

Index	The main influence factors	Decision vector {η low, η medium, η high}	Important degree	Easy availability (%)	Select or not
(a) Human resources	1. The teaching and research staff number	(1.83, 10.02, 65.15)	High	95.67	√
	2. The research staff accounted for all the higher education researchers proportion	(4.6, 15.17, 57.23)	High	94.39	√
	3. Management number	(15.1, 45.22, 16.68)	Medium	98.32	×
	4. Management staff accounted for all the higher education management personnel proportion	(14.8, 47.31, 14.89)	Medium	97.28	×
	5. Master degree or above in teaching staff number	(6.37, 9.8, 60.83)	High	98.15	√
	6. Overseas personnel quantity	(0.56, 19.21, 58.35)	High	93.17	√
	7. The external staff number	(5.81, 17.49, 53.7)	High	89.63	√
	8. Teacher qualification have an exam pass rate	(13.0, 40.22, 23.78)	Medium	98.91	×
(b) Funds investment	1. Annual budget total investment	(8.23, 39.98, 28.79)	Medium	98.22	×
	2. Per expenditure total investment	(4.47, 23.18, 49.35)	High	92.87	√
	3. Annual research funding	(16.1, 41.59, 19.31)	Medium	89.13	×
	4. Per investment of scientific research funds	(16.43, 21.2, 39.37)	High	87.25	√
	5. Annual funding for Education	(11.83, 45.37, 19.8)	Medium	85.16	×
	6. Per funding for Education	(3.3, 29.11, 44.59)	High	86.28	√
	7. Annual capital construction investment	(17.2, 39.77, 20.03)	Medium	88.19	×
	8. Per Capital construction expenditure	(4.02, 25.88, 47.1)	High	87.11	√
	9. Budget total investment occupies GDP proportion	(0.29, 21.21, 55.08)	High	90.21	√
(c) Infrastructure	1. The scale of university number over million people	(4.61, 32.61, 49.0)	High	99.03	√
	2. The total number of educational institutions	(6.31, 44.39, 26.3)	Medium	89.47	×
	3. The proportion of Educational institutions for higher education institutions	(6.37, 33.19, 37.44)	High	83.54	√
	4. Construction of network	(2.74, 17.23, 57.03)	High	72.51	√
	5. Quantity of the Multimedia classroom	(11.63, 22.1, 43.27)	High	85.13	√
	6. Total value of fixed assets	(9.27, 26.48, 41.25)	High	83.25	√
	7. Intangible assets	(11.5, 25.72, 39.78)	High	67.45	√

(continued)

Table 37.1 (continued)

Index	The main influence factors	Decision vector {η low, η medium, η high}	Important degree	Easy availability (%)	Select or not
(d) Management environment	1. Organ's administrative efficiency	(3.97, 23.9, 49.13)	Medium	53.31	×
	2. Policy formulation	(4.42, 26.07, 43.51)	High	68.83	√
	3. Constraint and incentive system	(2.03, 29.68, 45.29)	High	75.67	√
	4. Professional management personnel proportion	(6.8, 30.7, 39.5)	High	70.28	√
	5. Management decision making	(12.23, 23.3, 41.47)	Medium	52.39	×
	6. Related management department setting	(5.84, 26.37, 44.79)	High	77.88	√
	7. Propaganda and training	(3.07, 26.22, 47.71)	High	75.33	√
(e) Research outputs	1. University Enrollment	(9.77, 17.4, 49.83)	High	91.20	√
	2. Degree completion rate	(10.57, 40.23, 26.1)	Medium	93.07	×
	3. The employment rate of graduates	(8.09, 20.39, 48.52)	High	97.82	√
	4. The annual number of master degree awarded	(1.89, 27.3, 47.81)	High	98.99	√
	5. The absolute number of the annual provincial and ministerial level scientific research projects	(14.3, 21.35, 41.35)	High	97.36	√
	6. Annual scientific publishing quantity	(4.29, 39.3, 33.41)	Medium	92.11	×
	7. The number of annual research achievement award	(8.48, 23.8, 44.72)	High	93.45	√

The first class of high, $K = 1$, the Whiting function is

$$f_1(ij) = \begin{cases} 1 & d_{ij} \geq 7 \\ \dfrac{d_{ij} - 4}{7 - 4} & 4 < d_{ij} < 7 \\ 0 & d_{ij} \leq 4 \end{cases} \tag{37.1}$$

The second class of Medium, $K = 2$, the Whiting function is

$$f_2(ij) = \begin{cases} 0 & d_{ij} < 1 \\ \dfrac{d_{ij} - 1}{4 - 1} & 1 < d_{ij} < 4 \\ 1 & d_{ij} = 4 \\ \dfrac{7 - d_{ij}}{7 - 4} & 4 < d_{ij} < 7 \\ 0 & d_{ij} > 7 \end{cases} \tag{37.2}$$

The third class of low, $K = 3$, the Whiting function is

$$f_3(ij) = \begin{cases} 0 & d_{ij} \geq 4 \\ \dfrac{4 - d_{ij}}{4 - 1} & 1 < d_{ij} < 4 \\ 1 & d_{ij} \leq 1 \end{cases} \tag{37.3}$$

37.3.2 Calculation of Grey Clustering Decision Coefficient

Arrange and statistics the score of the degree of importance of the main influencing factors by the expert group, inductive and make into table. According to the grey statistical method formula (37.4), we calculate the grey clustering decision coefficient $\eta_k(j)$:

$$\eta_k(j) = \sum n(ij) f_k(ij) \tag{37.4}$$

Among them, $\eta_k(j)$ is the j affecting factor that belongs to the K gray type of decision coefficient. $f_k(ij)$ is the j affecting factor with i degree of importance for whiting function. $n(ij)$ is the number of experts that evaluate j influencing factor with i degree of importance.

37.3.3 Decision Vector

Each factor gray decision vector is made of three grey decision coefficients, $\{\eta_3(j), \eta_2(j), \eta_1(j)\}$ by formula (37.4), which are low, medium and high. All the survey data is consolidated and calculated by grey statistics method that the decision vector and related data are shown in Table 37.1.

37.4 The Key Factor Selection

On the selection process of the importance influencing factors, we considered the two aspects, the important degree and easy access. Only select the influencing factors of high category of important degree. Considering some factors can be acquired on the low side, the practical application in index system isn't operable, so remove the influencing factors access to less than 60 % in the high factors (in Table 37.1). We use $\surd$ to be the factors of influence, and $\times$ to be the influence factors of elimination. We finally select 26 key factors by operation (Table 37.1).

We determined the 26 indicators through the gray statistical analysis and availability screening. These indicators are used to determine higher agricultural education based resource management evaluation index system.

37.5 Experts Selection Tendency Analysis of the Key Influencing Factors in the Higher Agricultural Education

37.5.1 Combination of Comprehensive and Hierarchy

The results of the study show that, five one class indexes are retained, and the distribution of the secondary indexes when compared to other more balanced. Each one class index contains five or six secondary indexes. Cover the multi-layered information, such as teaching, research, management, input and output, higher agricultural education development, etc. Not only comprehensive index system, and there are clearly level.

37.5.2 Combination of Qualitative Index and Quantitative Index

In the initial indicators, there are seven qualitative indexes, and thirty one quantitative indexes. In the 12 factors removed, One of the ten index are quantitative index, just delete the two qualitative indexes, because hard to make an objective evaluation.

37.5.3 Combination of Scientific Nature and Operable

The results show that, elimination of influence factors is about 32 % of all the factors. It fully reflects the consideration of the scientific and operable by the related staff and experts on the evaluation index. Try to make the whole evaluation index system with minimal index that covers a maximum amount of information, in order to make the evaluation process strong operable.

37.6 Conclusion

At present, the research literatures about higher agricultural education resources management influence factors are scanty, so are the reference literatures, and the contents of the index are all the same. It's a difficulty of the research on higher agricultural education resources management influencing factors. Considering the above situation, combining questionnaire, consult and investigate repeatedly, collecting to be the initial set of indicators of the key factor in higher agricultural education resource management. By the grey statistical analysis and the available screening, we got 26 indexes with important impact. The scientific and reasonable of the indexes screening and the pooling of influence factors represented the view of the majority of the industry and peer experts with strong operable. What needed to point out, the key impact factor by screening was not static. With the continuous development of higher agricultural education of our country and constant attention of the government department, we need to add new important influence factor constantly, in order to make the evaluation more comprehensive and reasonable.

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Chapter 38
The Research on Expansibility of IE Tradition to Social Sciences

Ya-qiang Zhang

Abstract This thesis introduces the research tradition and analytical tools of Industrial Engineering (IE) to application research of social sciences. IE mainly concentrates on productive activities. However, the analyzing and solving of social problems put emphasis on both optimization of efficiency and effectiveness. It tends to hold the Problem-Driven thinking model and involves factors such as people, technology and environment which have more relative meanings. Even more important, solving social problems involves combinations of professional knowledges in more social science areas.

Keywords Effectiveness · Industrial engineering · Knowledge · Problem-driven · Social science

38.1 Introduction

Social science tends to develop towards two directions. One is that strengthening the practice of quantitative methods to a broader field of social science research, for example, to the field of history even philosophy study, so that the community research can also be tested and the results become more reliable. Another is the introduction of complexity systems thinking, social science system starts paying attention to goal-driven as well as its basis of rule-driven. Its practice trends have come up to be more engineering-oriented so that it can be directly carried out in social activities. Adoption of engineering methodology is meaningful to the construction of social science application tools, so this article attempts to introduce the study and practice tradition of Industrial Engineering to social science, and propose the corresponding framework of research.

Y. Zhang (✉)
Department of Business Administration, Xingtai University, Xingtai, Hebei, China
e-mail: tjhbzyq@126.com

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38.2 Development of Industrial Engineering

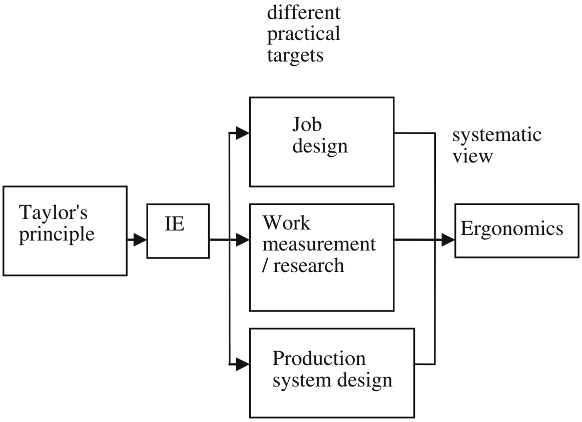
Industrial Engineering is a technological application discipline which originates from Taylor's scientific management principle (Jiashao 2003), (Rongqiu and Shihua 2005). Taylor's principle leads management practices up to theory, personal experiences up to real science. Even though there has been a lot of criticism, it is still the basis of modern management science. Nowadays it has developed into a research and practical system of IE which emphasis on the efficiency improvement and optimization of production systems.

38.2.1 Development of IE Application

The most authoritative explication of Industrial Engineering is made by the American Institute of Industrial Engineers (AIIF) as following: "Industrial Engineering is concerned with the design, improvement, and installation of integrated systems of people, material, information, equipment, and energy. It draws upon specialized knowledge and skills in the mathematical, physical, and social sciences together with the principles and methods of engineering analysis and design to specify, predict, and evaluate the results to be obtained from such systems" (Shuping and Guo 2005). In particular the 1970s and 1980s, with the development of production system itself, the basic functional character of production system turned from increasing productivity to cultivating excellent flexibility, IE formed different application systems according to different practical levels and targets (Qi et al. 2001), (Qi and Huo 2004), (Lin et al. 2007) (Fig. 38.1).

On the micro level of improving workers' efficiency, IE divided into two theories of job design and work measurement to implement the efficiency of production management and labor management. For the production system level, it

Fig. 38.1 The development of industrial engineering application



combined with production management to form a lot of contents such as the research of design and construction of production system. System-based perspective and the integrated treatment of relationship between people, machine and environment formed the direction of the ergonomics research. Of course, ergonomics gave different emphasis to the study of three elements, for example, more emphasis on people made the branch of human factors engineering.

38.2.2 Characteristics and Expansibility of IE Tradition

With the rapid development of high technology, techniques and methods to improve productivity or efficiency will continue to increase and update, the contents of IE will also continuously enrich and change. Thanks to the stability of target and the ability of technology innovation, IE can ensure greater vitality and wider instruction of this comprehensive application engineering.

1. *The object of IE study is the production system.* However, this production system is no longer confined to manufacturing enterprises, or material production sectors, but also refers to the operation system of service. That is to say the study range of IE gradually extended from manufacturing activities to general organizational activities, and then maybe to even more humanities and social activities. For example, ergonomics got new connotation on research object which considers it as the study of all the human–machine relations in the process of designing manufacturing and using of man-made objects (Wang 2001); In addition, Educational Ergonomics theory was founded to solve the problems of ergonomic education, the Participatory Ergonomics was founded to find theory and method to effectively apply Ergonomics methods and principles to practical issues (Lu 2009).
2. *The goal of IE is to improve operational efficiency.* Although modern operating systems put more emphasis on the study of market responsiveness (effectiveness), but improving efficiency is still the eternal theme for economic activities. IE studies the improvement of effectiveness on the basis of concentrating on different effectiveness problem, and then IE formed many develop themes and directions, and it also got sustained momentum. To social and humane system and its practice, continuous effectiveness improvement of social activities and the design and timely surpassing of efficiency is also the key issue, effectiveness will get even more attention.
3. *The essence of IE is continuous improvement* which emphasizes on continuously development of potential, convinces the "best" work methods and concentrates on the maximum overall efficiency. Promoting the spirit of keeping hungry to wider range of social activities will be beneficial to preservation and improvement of beneficial human activities and the continuous and in-depth innovation of the effectiveness system.

4. *IE offers a group of standardized charts* which can help industrial engineers record and analyze the facts by providing the standard expression and language base. That is why IE is widely used. In the field of social action, it is necessary to build a similar, but adaptive diagram expressions and model tools. In addition to the description and analysis of social issues, it should be the innovative mechanisms for executing abundant social knowledge.

38.3 The Expanding of IE Tradition to Social Areas

Industrial Engineering is mainly concerned with productive activities which are special case of people's social activities. These production activities have some similar features, but social and humane activities present more complex features compared with the simple production systems. Based on the above analysis, IE research and application tradition need to expand to social science, drawing lessons from some research framework but also having its own characteristics.

Application research on social and humane activities or the so-called social communication activities will similarly involve analysis framework (Fig. 38.2) of people-technology—environment. It's no doubt that the object and emphasis of research, the knowledge and the development of practical tools in related areas have obvious differences.

At first, compared with the productive and operational activities, general social communication activities stress not only on efficiency but also utility/effectiveness, so that we should delimit the goal of social activities study to effectiveness which includes the dual objective of both efficiency and effectiveness optimization. Developing the description measurement and analysis tools of effectiveness based on positively introduction of diagram and model of IE will become an important research direction.

Concerns about the effectiveness of action make the trend of social communication study into analytical thinking of Problem-Driven. By Problem-Driven means first we should analyze the kind of problem we facing, then find solutions in the existing knowledge. Different from the pure problem description and analysis of the IE tool, research tools of social and humane activities is much more problem-solving, it is a problem analysis tool and also a knowledge base for problem solving. The tools include accumulation, summarization, simplification of professional knowledge in many categories and also a knowledge search and confirmation mechanism. Reference (Caplan et al. 2010) tried to introduce the professional knowledge in human factors engineering to the conflict resolution mechanisms of TRIZ (Altshulle 1988) (Theory of Inventive Problem Solving). This attempt increases practicability of human factors engineering, and has a strong expansion value. Development of such tools for problem analysis and resolution can stimulate the resolution of the continuing out-coming and complicated social and humane activities. It can also facilitate the use of complex social

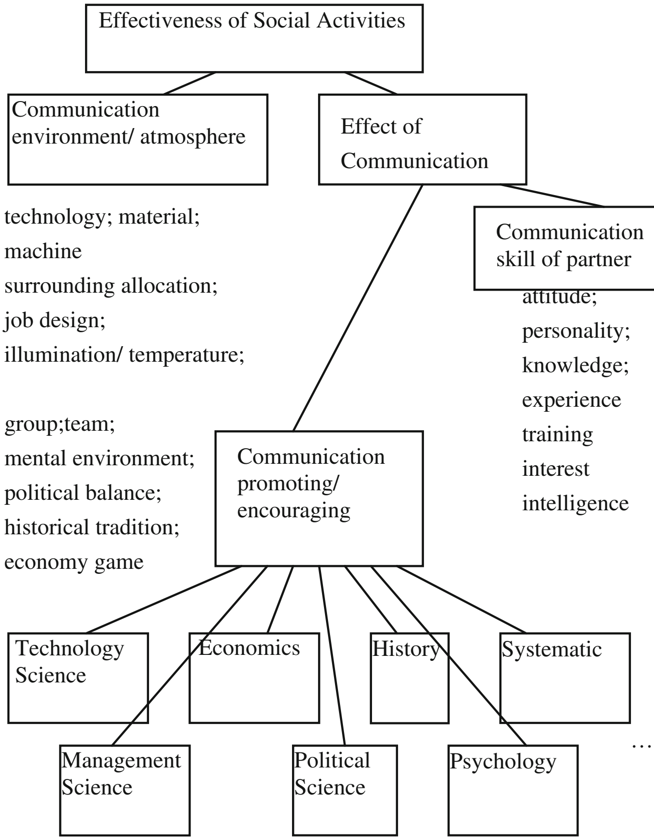
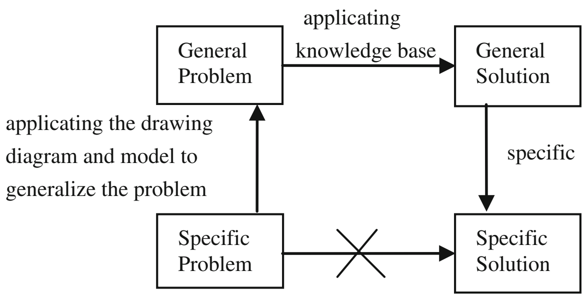


Fig. 38.2 The factors affecting social activities

scientific knowledge. Draw lessons from the innovative theory, the process of solving social problems with such tools can be summarized as Fig. 38.3.

In addition, in the research of social activities, technical factors have a broader meaning, or you can call objects factor. Such factors not only refers to the general sense of the engineering technical factors, but also social technical factors. For example, economic mechanisms, political balance mechanisms, cultural transmission mechanism, mechanism for conflict game, system emergence mechanisms etc. Analysis of objects factor has a relative meaning, which is whether a factor belonging to the analysis of objects or people (participants) or the environmental factor may lie on specific circumstances. If the analysis is limited to the scope of participant's behavior then it belongs to the human factor; if the study is related to the communication promotion mechanism, we should attribute it objects factors; if it involves the analysis of the environment and atmosphere, it must be the analysis of environment factor.

Fig. 38.3 The solution process of social problem



Thus, the study of social communication environment/atmosphere includes the research of rigid environment, machines, work and also the flexible social mechanism/atmosphere. Moreover, the study of social activity effect includes scientific, technical engineering knowledge, also the practice of various social professional knowledge, in particular includes the research on the setting of social communication mechanism.

38.4 Conclusion

The introduction of IE research tradition and appropriate tools will encourage the study of engineering method system which can solve social and humane activities. But this opportunity focuses more on analysis and description of the problem. Due to the complexity of social problems and social scientific knowledge, the corresponding research direction is carrying out the Problem-Driven innovation system. This system is not only a tool system for analyzing problems, but also a knowledge base for social science, as well as a research and confirmation mechanism based on specific questions. For the dilemmas when people facing complex social problems always appear either too little/much (no combing) knowledge or the lack of mechanisms of knowledge search methods to specific question.

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Chapter 39
The Research on Knowledge Spillover of Industry-University-Research Institute Collaboration Innovation Network

Li-ping Fu, Xiao-ming Zhou and Yue-feng Luo

Abstract Industry-University-Research institute collaboration innovation network is the important part of national innovation system, and knowledge spillover is key knowledge flowing mechanism of Industry-University-Research institute collaboration innovation network. This paper defines and generalizes knowledge spillover of Industry-University-Research institute collaboration innovation network, demonstrates the adjustment mechanism of knowledge spillover combined with 3 phases of run-in coordination, standard development and spiral rising, analyzes the relevant effect on innovation network, innovation main body, regional industrial cluster, innovation capability and economy increasing, at last promotes expectation of further research.

Keywords Adjustment mechanism · Collaboration · Knowledge spillover · Industry-university-research institute · Innovation network

39.1 Introduction

Science and technology evaluation system of Chinese universities and institutes always considers research production more important than technology conversion. Enterprises are affected by constraint of scale, currency flow, R&D staff and

L. Fu (✉) · X. Zhou · Y. Luo
Public Resources Management Research Center, School of Management Tianjin University, Tianjin, China
e-mail: lipingfu@tju.edu.cn

X. Zhou
e-mail: zhxm_cugb_tju@sina.com

Y. Luo
e-mail: luoyuefeng@vip.sohu.net

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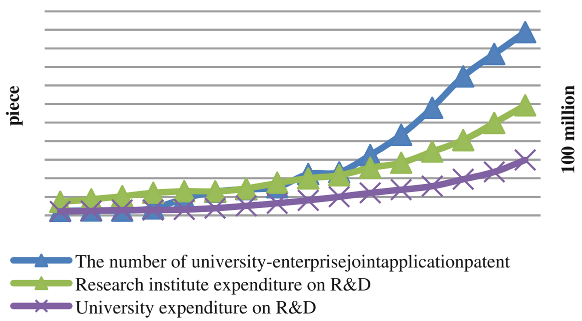
innovation resource. Different kinds of intermediary organizations that provide service of information, consultation, visa, financing and risk investment are so few. Intellectual property rights protection, economy development level, innovation culture, innovation policy and collaboration profit distribution limit the innovation environment. Therefore, as the main source of technology innovation, national universities institutes and enterprises collaborate not smoothly, collaboration mode is single and collaboration mechanism is not regular. So, at the year of 1992, our country initiated "Industry-University-Research institute collaboration development program". Especially, at the year of 2007, our country advanced officially: speeding up to establish the technology innovation system which takes enterprises as main body and market as guide, based on Industry-University-Research institute collaboration; leading and supporting key innovation elements to centralize to enterprise, so as to transfer technology innovation outputs to practical productive force. Various industry technology innovation strategy unions appeared, promoting the concordance of national universities, realizing that universities and institutes share the talents. Collaboration of institutes and enterprises becomes more and more frequent, and the collaboration mode changes from point to point to tridimensional network pattern (Liu et al. 2011). Date of last recent years, the number of Chinese university-enterprise joint application patent, the university and research institute expenditure on R&D, rise step by step (Fig. 39.1), describing that the collaboration become closer, and the innovation outputs increase.

Knowledge spillover is key mechanism of Industry-University-Research institute collaboration innovation network formation and development. Whereas, the organization mode and operation mechanism of Industry-University-Research institute collaboration innovation network provides convenient condition for knowledge spillover. Through the research of experts such as Drucker (1999), scholars of management science and economics come to a conclusion that knowledge spillover is as important as knowledge innovation. Knowledge spillover makes obvious contribution to speed up industrialization of technology production, promotes high-tech industry development and conventional industry upgrade, and improves innovation capability of network and its main body.

As Freeman (1991) firstly advanced "innovation network" (Freeman 1991), the worldwide research became more and more abundant in innovation network.

Fig. 39.1 The number of university-enterprise joint application patent and university and research institute expenditure on R&D



Etzkowitz and Leydesdorff (1999) advanced “Universities-Industry-Government” 3-helix innovation model, which set solid base of university—enterprise collaboration research. Zhu and Peng (2003) firstly advanced Industry-University-Research institute collaboration innovation network. Mowery (1998) indicates that the motivation for enterprise to participate in collaboration is to acquire knowledge spillover and reduce development cost. However, similar researches focus on: organization mode and operation mechanism of collaboration innovation network, evolution process, network ability and knowledge transfer and integration, etc. Ke (2010), Xu et al. (2011), Hui and Zhou (2010), and knowledge spillover of industrial cluster innovation network or technology innovation network (Gui 2008; Jiang 2003). But knowledge spillover mechanism of different kinds of innovation network is different. So, knowledge spillover of Industry-University-Research institute collaboration innovation network needs to be researched systematically.

39.2 Definition of Knowledge Spillover of Industry-University-Research Institute Collaboration Innovation Network

Based on knowledge chain of dynamic knowledge network, collaboration innovation network shows its value as to provide main body of innovation network the method of matching the uncertainty of technology and market, and the solution to complexity in innovation process, so as to lower down R&D cost and risk. The network contains knowledge innovation of main body through collaboration, but also knowledge transfer based on technology transaction, patent authorization and collaboration with share of technology, together with knowledge spillover based on knowledge sharing, enterprise derivation, talent flowing, personnel and technology communication.

Knowledge spillover of collaboration innovation network means as the discrepancy of knowledge stock and configuration of main bodies, innovation network forms a series of processes that knowledge spillover from the knowledge source, transferred in network, absorbed and innovated again by the knowledge recipient, through the official innovation network based on agreement, and unofficial innovation network based on incompact agreement or exceeding the agreement limitation. To be different with innovation network of industrial cluster network and regional innovation network, the relationship between main bodies of collaboration innovation network isn’t the type of market competition, so it seldom appears to minimize the knowledge spillover of its own and maximize the learning from others as “Hitchhike” in management strategy. Based on the 3-helix innovation model with “Government-Enterprise-University” of Etzkowitz and Leydesdorff (1999), collaboration model of Santoro (Santoro et al. 2000), together with the above definition to deliver the conceptual model as Fig. 39.2.

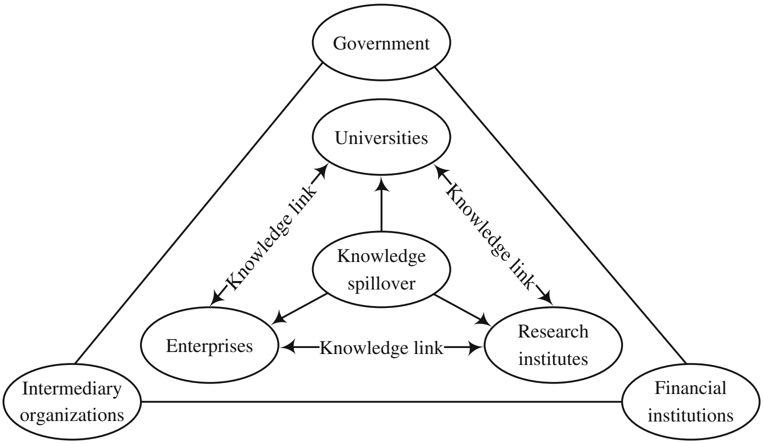


Fig. 39.2 The model of knowledge spillover of industry-university-research institute collaboration innovation network

Table 39.1 Different knowledge spillover of collaboration innovation network

Dimension	Type	Characteristic
Subjective willing	Voluntary	Voluntary and initiative, subject to the control of spillover source, adjustment with the relationship between each other
	Involuntary	Involuntary, in part or completely uncontrollable, the objective existence
Knowledge character	Dominant	Dominant or encoded knowledge
	Subdominant	Hidden or silent knowledge
Main body	Vertical	Spillover between different types of enterprises universities or institutes
	Level	Spillover between the same type of enterprises universities or institutes
Spillover carrier	Carrier of human	By the flow of talent, personnel exchanges and cooperation seminars
	Carrier of object	Through technical literature, patents for inventions and products
Spillover direction	University and institute to enterprise	Spillover of basic research, applied basic research and knowledge
	Enterprise to university and institute	Spillover of production technology, market information and management methods and experience
Spillover range	Network internal	Inside the network
	Network external	Beyond the network, the core nodes of the network act as "gatekeepers"

Based on different dimensions, we can come to a conclusion of the different types and characteristics of knowledge spillover of collaboration innovation network, as Table 39.1.

39.3 Adjustment Mechanism of Knowledge Spillover to Collaboration Innovation Network

Collaboration innovation network is composed with highly autonomy members by means of loosen style to form a new innovation union, further step to form knowledge network with equal nodes, which belongs to loosely coupled system (Zhang et al. 2012). Its form and evolution mechanism is in accordance with complex scale-free network based on features of self- increasing and preferred connectivity (Feng et al. 2009). We can derivate from social network and capital theory, through long-time official contact collaboration and unofficial communication of technology and staff, relationship capital of the network accumulates day by day, together with deeper and deeper reliance. Therefore, in the innovation network, two features of scale-free network and network relationship capital form evolution power of innovation network.

Ke indicates that collaboration innovation network evolution includes: run-in period, coordination period, specification period and development period, matching four kinds of knowledge transferring mode: spontaneous mode, competition mode, collaboration mode and the altruism mode (Ke 2010). Based on the research conclusion and the development law of innovation network, this paper divides innovation network evolution process into 3 sections: run-in coordination period, standard development period and spiral rising period. At the same time, based on improvement of knowledge spillover in regional innovation network by Gui (2008), it defines the innovation knowledge that enterprises (technology demand party) get through the methods of cooperative research, technology introduction, technology transaction based on agreement as direct demand, and defines the innovation knowledge that enterprises get through the unofficial methods of talent flowing, staff communication and technology seminar as indirect demand. Addition of the two demands above is defined as total demand of technology demand party. Accordingly, it defines the innovation knowledge that is provided by universities and research institutes (technology supply party), trough by-self and cooperative innovation, as the total supply. Suppose that in the collaboration innovation network, each main body complies with intellectual property right protection principle based on ideal and serious protection system and environment.

39.3.1 Run-in Coordination Period

Collaboration innovation network initiates newly, each main body gets different understanding attitude and goal, lack of knowing understanding and trust between each other, and different in the aspect of organization background and culture. So, everyone is cautious to enter the innovation network to learn knowledge supply-provide information, communicate or collaborate with each other, and resolve contradictions. So inside the network, spillover from technology field to economic

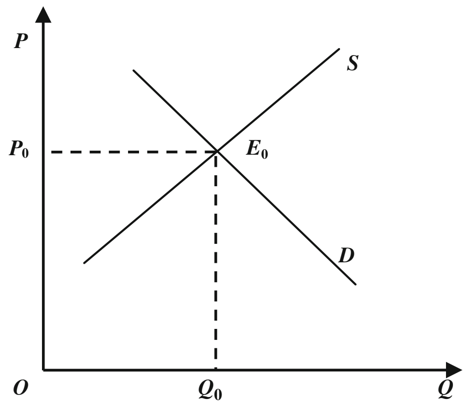


Fig. 39.3 Knowledge supply-provide balance in innovation network of run-in coordination period

field is so little that even could be ignored. Technology demand party attains the innovation knowledge by means of collaborating with supply party on technology research, technology introduction, technology transaction based on agreement. As in Fig. 39.3, direct demand to innovation knowledge is the total demand, when it comes to the balance, total supply curve S will intersects with total demand curve D at point E_0, Q_0 is the balance quantity of innovation knowledge, and P_0 is the balance price of innovation knowledge.

39.3.2 Standard Development Period

With the development of collaboration innovation network, each main body strengthens the relationship, deepens the trust, cooperates more and more standard, and collaboration goal is clearer. Then, it evolves to more solid combination in control, and network stability and main body embeddedness gets stronger, leading to more stable work mechanism and closer communication between staff and technology. Now, it forms favorable condition for knowledge spillover, on condition that universities and institutes protect the core technology or knowledge of their own, knowledge spillover happens and accumulates more and more. On condition that total demand is fixed, for the reason that knowledge spillover leads to indirect demand increases, direct demand decreases accordingly (Fig. 39.4).

As Fig. 39.4, demand curve D descends to D_1, it leads rarity of network internal innovation knowledge gets down, balance point would then come down; price would come down, balance point transfers from E_0 to E_1. As network evolves, demand party will increase knowledge stock through collaboration absorption and knowledge spillover, supply and demand party comes closer in the knowledge position, meanwhile difference of knowledge structure of two sides descends. In Fig. 39.4, supply curve S transfers to the left S_1, on condition that demand is fixed, rarity of network internal innovation knowledge rises, price rises and balance point transfers from E_1 to E_2.

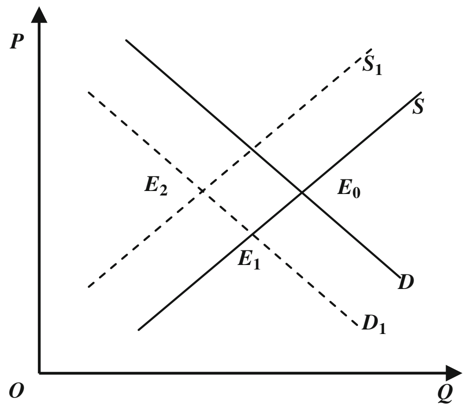


Fig. 39.4 Knowledge supply-provide balance in innovation network of specification development period

39.3.3 Spiral Rising Period

Collaboration innovation network asks for higher level, after specification development period, it comes to stable state. Outside the network, market competition, market demand, and technology innovations demand the network to suit to environment. Network faces new chance and pressure of adjustment. Now, as the majority of demand party, enterprises increase demand on technology and product upgrade more and more. As Fig. 39.5, demand curve transfers from D to D_2, leading to network internal innovation knowledge rarity rise, balance price rises, balance point transfers from E_0 to E_3. As the majority of knowledge and technology supply party, universities and institutes raise their knowledge position compared with the technology demand party by means of increment of product and technology innovation, so as to amplify the discrepancy in knowledge structure of two parties and supply of innovation knowledge increases. In Fig. 39.5, supply curve transfers from S to S_2, on condition that demand is fixed, rarity of network internal innovation knowledge descends, price descends and balance point transfers from E_3 to E_4.

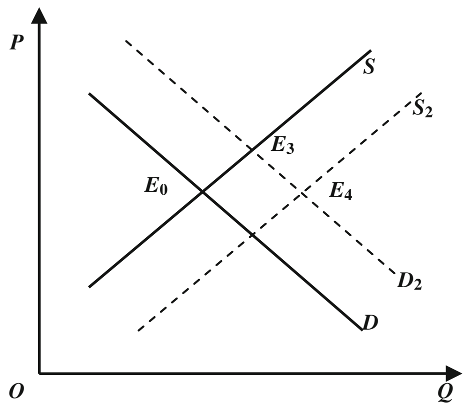


Fig. 39.5 Knowledge supply-provide balance in innovation network of spiral rising period

39.4 Analysis on the Effects of Knowledge Spillover of Collaboration Innovation Network

Knowledge has the feature of noncompetitive and exclusive, so it has the effect of public property and external. However, knowledge spillover of collaboration innovation network does not only have the “distribution effect” in the common external character, at the same time it also has “production effect” and affects the innovation performance of whole network and collaboration main body. Through knowledge spillover, it forms the public knowledge pool, each main body interacts with network, spirally rises, adds knowledge stock etc. based on network public and their own knowledge. Therefore, knowledge spillover of collaboration innovation network affects the innovation network, cooperative main body and relevant region with corresponding economy effect.

39.4.1 For Innovation Network

The ultimate goal of collaboration is to achieve knowledge value creation; it mainly depends on the effective transaction of knowledge between each main body. At first, knowledge spillover is considered to be the supplementary of collaboration innovation network based on official agreement. It can speed up the internal knowledge flowing, increase the efficiency of knowledge transaction between main bodies, and increase the knowledge creation capability of network (Ke 2010). Secondly, knowledge spillover will form network public knowledge pool, which will make each main body create more efficiently on public technology platform, and innovate again through the absorbed knowledge by means of network interaction, further to increase public knowledge stock and promote creation ability and efficiency of network (Gui 2008). Thirdly, production technology, market information and management experience transfers from enterprises to institutes. Therefore, it can strengthen market demand guide, optimize the use of innovation resource, and promote network creation capability and capacity for sustainable development. Fourthly, knowledge spillover is in favor of network to form mechanism of collective learning and promote the collection of talents from all main bodies.

39.4.2 For Innovation Main Body

Enterprises can attain knowledge spillover effect through collaboration, and then reduce research cost, transaction cost and uncertainty, achieve research scale economic effect. What’s more, through knowledge spillover, enterprises could also attain all kinds of external knowledge such as public knowledge and innovation knowledge of other enterprises, and promote knowledge learning and absorption ability and technology creation ability (Cyert and Goodman 1997) by means of all kinds of communication, research and seminar. For university and research institute, subjective and objective knowledge spillover will reduce the position distance between enterprises and them, and promote efficiency and width of knowledge transfer, speed up propagation of new thought, new concept, new information and new technology. What's more, knowledge spillover promotes institutes come across organizational boundaries, transfer and integrate knowledge timely and efficiently in space and time, and then it's more in favor of transferring subdominant knowledge to the internal network. At last, knowledge spillover can make universities and research institutes attain market information in time, understand real problems, then improve the use of new technology and make research activity conform economic closely (Diao et al. 2009).

39.4.3 For the Region

At first, the knowledge spillover of collaboration innovation network is the main power of regional industrial cluster effect. Fujita and Thisse (2002) indicate: cost external and technology external leaded by knowledge spillover together is the key reason of economic activity agglomeration. As existence of public knowledge pool, it leads to marginal productivity rate of network internal enterprises rises, then make network get more efficient. Secondly, it is an important factor of affecting regional innovation efficiency and capability. Wei et al. (2010) research that regional innovation ability is not only affected by R&D input, but also relies on regional innovation efficiency. Innovation efficiency relies on special factor, including: industrial cluster environment, combination quality, ability of absorbing knowledge spillover outside the region. Thirdly, knowledge spillover of collaboration innovation network promotes total factor productivity and high-tech industry, and then affects regional economy increase. Kose and Moomaw research knowledge spillover effect on Europe regional economy increase, through analysis on improvement of 57 regions from France, Italy and Spain, they indicate: R&D intension and R&D spillover both affect the region economy increase positively.

39.5 Discussion

This paper combines collaboration innovation network and knowledge spillover, promotes the definition of knowledge spillover of collaboration innovation network, and describes it based on subjective willing, knowledge type, main body, spillover carrier, spillover direction, spillover range. By means of micro-economics supply–demand analysis method, it analyzes three periods of knowledge spillover of collaboration innovation network which are run-in coordination period, specification development period and spiral rising period, and indicates the adjustment mechanism of knowledge spillover on network internal knowledge. As known from analysis, knowledge spillover dynamically affects the balance of knowledge supply and demand in the network; through affecting direct knowledge demand, it can change the knowledge distance between two parties, and impel the innovation capability of collaboration innovation network and spiral evolution of the network. At last, it analyzes effects of knowledge spillover on network development, innovation capability and performance of main bodies, region industrial cluster and economy increase.

Collaboration innovation network's ultimate value is knowledge creation, flowing and value addition. Knowledge spillover is the important knowledge flow mechanism of collaboration innovation network, it has great significance to impel collaboration to cycle methodically, to promote market configuration of innovation resource, and to achieve the sustainable development of collaboration innovation. For the lack of research in this paper, follow-up research could be improved as followings: firstly, to analyze knowledge spillover of collaboration innovation network from micro mechanism and relevant influencing factors (e.g., collaboration benefit distribution and sharing mechanism); secondly, to carve up the main body of collaboration innovation network more appropriately, fully considering discrepancy of university, institute and enterprise on condition of type, scale, innovation resource and efficiency; thirdly, to discuss about relevant measure and estimation method, and impel the method of quantitative analysis; fourthly, to analyze its effects from all aspects, including both the positive and the negative.

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Chapter 40
Review of Culture Industry Agglomeration on the Influencing Factors, Characteristics and Empirical Researches

Li-ping Fu, Yong-jun He and Jun-hui Li

Abstract Culture industry agglomeration refers to that a large number of closely linked culture enterprises and support institutions gathered together in space, demonstrating strong and sustainable competitive advantage by collaboration. In terms of policy, China's "12th Five-Year Plan" proposed to develop the culture industry. In addition, the 17th Session of the 6th CCP Plenary Conference has made a comprehensive plan on the development of culture industries, which indicates it has become an important issue in this era. Currently, researches on culture industry agglomeration mainly focus on influencing factors, characteristics and research methods at home and abroad. This paper is a literature review of the relevant literature, aiming to provide a theoretical reference for the development of China's culture industry.

Keywords Agglomeration characteristics · Culture industry · Industry agglomeration

40.1 Introduction

With the arrival of economic globalization in the 21st century, culture industry has become the 4th growth pole and a new pattern of economic growth for the developed countries. It demonstrates the soft power of both the country and

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L. Fu (✉) · Y. He · J. Li
Public Resources Management Research Center, School of Management
Tianjin University, Tianjin, China
e-mail: lipingfu@tju.edu.cn

Y. He
e-mail: woxincareer@hotmail.com

J. Li
e-mail: junhuili@tju.edu.cn

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the enterprises (Cao 2007). Due to its great importance, the national "12th Five-Year Plan" in February 2012 also proposed to develop culture industry, deepening culture restructuring, promoting greater development and prosperity of socialist culture, and following up significant culture industry demonstration projects[1]. To speed up the development of culture industry has become a key strategic move for our country. It helps us to seize the vital strategic opportunities of this century and create the new situation of socialist culture construction, which ensures the fully realization of the strategic objectives of building a moderately prosperous society.

Culture industry agglomeration is a huge cluster of industries. In it, various formats are mutually independent but closely linked in order to achieve common development. One of the distinctive features of culture industry is agglomeration during the development process. In other words, in the field of culture industry (usually taking media industry as the core), by a large number of closely linked culture enterprises and support institutions (including research institutions) gathered in cluster in space, forming a strong and sustainable competitive advantage through collaboration (Xiang 2005). From 1979 to 2012 (before this paper is written), Chinese Journal Full-text database and Chinese Academic Journal (century journals) in CNKI has collected 333 relevant papers on culture industry agglomeration, far below the number of 274,632 papers on culture industry, which reveals the researches on culture industry agglomeration is relatively weak domestically. Therefore, strengthening the research on culture industries, accelerating the development and optimizing the layout of the culture industries is of both theoretical and realistic significance.

By a systematic literature review on culture industry agglomeration both home and abroad, it could be found out that the researches mainly focus on influencing factors, characteristics and empirical research of culture industry agglomeration currently.

40.2 Researches on Influencing Factors of Culture Industry Agglomeration

The main impact factor of industry agglomeration usually is the external economic scale or economic scope. Namely, the enterprises stationed in the same industry cluster could save cost than they are scattered separately. This paper maintains that there are five influencing factors of culture industry agglomeration compared with the other ones.

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[1] http://www.cfi.net.cn/newspage.aspx?id=20111015000427&p=1 (in Chinese).

40.2.1 Cultural Resources

Tangible or intangible cultural resources are the basis of the cultural industry agglomeration. Alan Scott, professor of the University of California, finds out that Hollywood film industry has many local cultural resources, such as street layouts, natural scenery, lifestyles and so on. These resources not only bring unique flavor and spirit to the local film industry products, but also help to shape new images of Hollywood and South California (reality or fiction). Therefore, the film industry is favored by the local cultural fund. When a new round of production is started, the cultural resources have become the input of the new production (Scott 2005).

40.2.2 Creative Talents

In the 1980s, Zukin began to pay attention to the important role of various cultural producers played in culture industry agglomeration, such as artists, craftspeople, designers, and musicians. Allen Scott focuses on the empirical research of the Hollywood culture industry. He analyzes the causes of the culture industries from the perspective of labor resources, and finally sums up the elements of culture industry agglomeration. The results include elements of human capital, cultural capital and economic capital (Scott 2005). Richard Florida proposes that culture industry agglomeration is, first and foremost, the gathering of creative talents. Then, the creative talents would attract enterprises to settle in the place. Therefore, talents are the fundamental driving force of the formation and development of culture industry agglomeration. In addition, the government has to formulate policies to attract businesses and creative talents as well (Florida 2002a, b).

Researchers Yusuf and Nabeshima (2006), Pratt (2004), Currid (2006), and Scott explores the creative talents' impact on the culture industry agglomeration from the geospatial perspective. In the article Culture Industry: Geographical Distribution and Creative Fields, Scott points out "the development process during inter-enterprise exchanges and local labor market of culture economy promotes the aggregation tendency of the production system and geographic environment, and producing the high-return effect. It not only improves the efficiency of production systems, but also improves their creativity, and this phenomenon is not so obviously manifested in any other production situations" (Lee 2001).

John Hawkins, known as the father of the creative industries, along with Lee (2001), Markoff (2005) Knudsen, gives highly concern and attention on the important role the creative talents played during the process of culture industry agglomeration and development.

40.2.3 Agglomeration Environment

Most of the scholars believe that the central city or metropolis is equipped with the basic conditions of culture industry agglomeration, which effectively attracts a variety of outstanding creative talents. It is the fundamental of the interaction between environment and other factors. Researchers Molotch (1996), Mitchell (1999), Landry's (2006, 2003), Bathelt (2004) and Hutton (2000, 2004) indicate that the characteristics, such as open, tolerable, low entry barriers, cultural diversity, and implementation of public service in big cities provide the basic environment of culture industry agglomeration. Caves 2002, Florida (2002a) and Gertler (2004), Hall (2000) also have the similar conclusion. Through a case study on a city, Hall proposes the city offers a favorable agglomeration environment for different groups of people's integration, communication and exchanging, and mutual collisions (Markusen and King 2003).

However, Gibson and Cornell put forward a different view. They noted that the rural areas of the United Kingdom, Australia, New Zealand and other countries, are equipped with the implemented infrastructure, which contributes to the remote office work and the entrance of the arts and culture industry sectors of the rural areas. Therefore, culture industry agglomeration is not only existed in big cities, rural areas are also available (Porter 1998).

40.2.4 Government Support

The experience of cultural and creative industries in developed countries demonstrates that the government plays an important role for resource allocation in the culture industry agglomeration. In the meantime, the effectiveness of resource allocation directly determines the concentration of culture industry development. This paper holds a similar conclusion in accordance with the influencing factors of Scottish film and television industry. In the terms of scope and persistence, national institutions, multinational organizations and government regulations is more important than the localization network. Based on the current status of cultural and creative industries agglomeration in Shanghai, chairman of Shanghai Creative Industry Association, Li Wuwei advocates that the key factor to promote the development of cultural and creative industries in Shanghai is to create a favorable environment by institutional innovation and policy support. In addition, a favorable environment is the direct performance of the implementation of effective policy support. This paper argues that government should take full consideration of the culture industry agglomeration, including a unified planning and full feasibility studies. Through the reform of the cultural management system, developing multiple sources of funding, deepening the intellectual property protection, and supporting the easing policy, the cultural and creative industries could get effective protection and achieve sustainable development (Fig. 40.1).

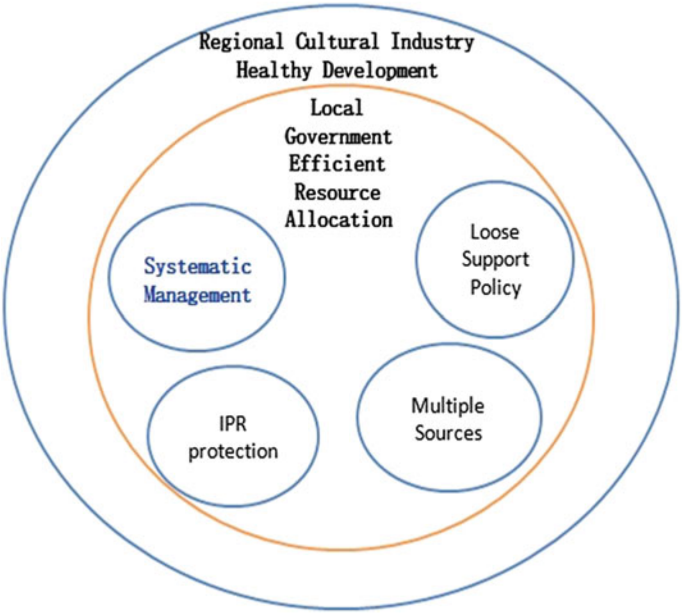

Fig. 40.1 Government's allocation on cultural resources

40.2.5 Capital Operation

French sociologist Pierre Bourdieu indicates that capital in various markets competence in the society can be divided into four basic types, economic capital, cultural capital, social capital, and other symbols of the capital. Among them, the combination of cultural resources and other forms of capital could be transferred into operational one, named as cultural capital. In the new competitive advantageous model, cultural capital functions as a special production element. It is focused and invested as a kind of weapon relating to interest and competition, while the competition in the field of cultural products and social class has always been ongoing. Prof. Li Siqu proposes "3P Culture Industry Strategy" (Creative Power, Influencing Power and Cultural capital the transform Power, abbreviated as 3P), in order to enhance the cultural capital and creative force, strengthen the influencing power, and construct a new measure system of culture industries. The index can be measured by value utilization rate (including the contribution rate of cultural resources and the utilization rate of the cultural industry), industry contribution rate (including the industry contribution rate, the employment contribution rate, the export contribution rate), brand contribution rate (including brand value rate, brand-led force). This paper maintains that under the current ever-advancing background of macroeconomic and financial market, capital operation of culture industry is particularly critical. By means of taking full advantages of capital market financing, resource allocation, innovation and other functions, cultural industries' inner growth demand could be

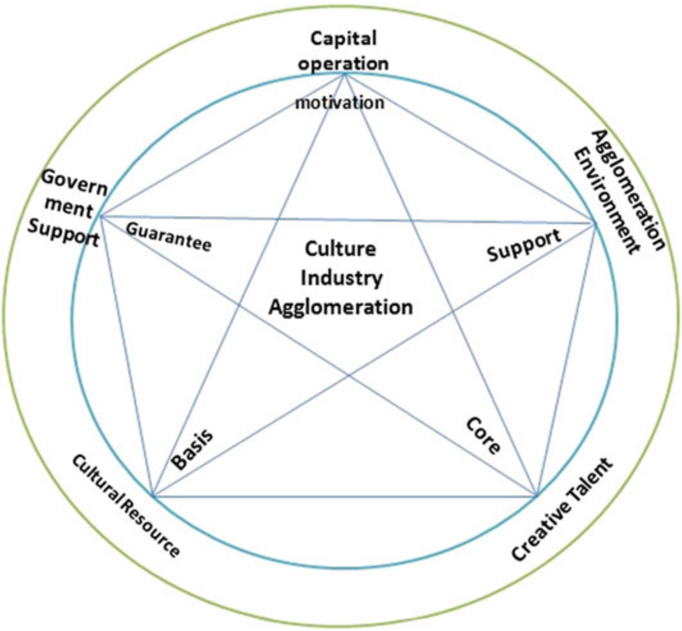

Fig. 40.2 Five factors influencing culture industry agglomeration

quickly released, which follows the capital's trend for seeking profits controllably. It will greatly promote the development of culture industry agglomeration.

There are many factors causing the development of culture industry agglomeration, such as "a specific historical background, a good correlation industry status, one or two innovative companies (Florida 2002a)", and a specific market demand. However, these distinctive factors are all locally immovable. Moreover, they are scarce in number, difficult in imitation, and irreplaceable. To sum up, there are five influencing factors for culture industry agglomeration, including cultural resources, creative talents, gathering environment, government support, and capital operation. Among them, cultural resources is the basis for the development; creative talent, the core; gathering environment, the support; government assistance, the guarantee; capital operation, the driving force. The relationship between the five factors is shown in Fig. 40.2.

40.3 Researches on the Characteristics of Culture Industry Agglomeration

By the analysis of the formation and development of culture industry agglomeration, this paper tries to summarize the common features of each phase from the development of culture industry agglomeration, and attempts to comparatively analyze the difference between culture industry agglomeration and traditional industries agglomeration.

40.3.1 Features of Culture Industry Agglomeration—From the Development Perspective

There are three features of culture industry agglomeration from the development perspective.

First, creativity and innovation factors have a remarkable effect on culture industry agglomeration. The development of culture industry agglomeration emphasizes on creativity and innovation.

Second, culture industry agglomeration could optimize the network structure. The core of the culture industry agglomeration is to build a value chain and also its extension. During the process of gathering, the cultural enterprises try to interact with the alliance, and constantly optimize the network structure.

Third, culture industry agglomeration accelerates the formation of the agglomeration and its in-depth evolution. Scott indicates that a strong correlation between the cultural enterprises will eventually lead to industry concentration, and finally shapes large agglomeration.

40.3.2 Features of Culture Industry Agglomeration—From the Comparative Perspective

Some researchers are more concerned on the distinction and connection of the culture industry agglomeration with traditional ones. Thus, they unfold their researches on the characteristics of culture industry agglomeration. After an in-depth analysis on the relevant ideas, this paper sums up that there are three differences between culture industry agglomeration and traditional industries. It is shown in Table 40.1.

As Florida (2002a) suggests, the difference between culture industry agglomeration and traditional ones is in essence. Cultural and creative behavior requires a loose connection, because close contact will make internal groups to exclude outsiders. However, diversity is an important factor in the development of cultural industries. In terms of gathering content, cultural industries contain working and living environment of creative individuals, non-profit institutions, cultural institutions, arts venues, media centers and different types of artists. The agglomeration is both a place of cultural production and cultural consumption. Traditional industry agglomeration is, first and foremost, the gathering of the enterprises. Then the companies will attract talents to settle in. On the contrary, in culture industry agglomeration, talents attract enterprises stationed together. Therefore, it is more

Table 40.1 Differences between traditional industries agglomeration and culture industry agglomeration

Difference	Traditional industries agglomeration	Culture industry agglomeration
Essential difference	Needing close contact	Needing loose contact
Content	Not containing working and living environment	Containing working and living environment
Mode	Talents gathering after enterprises gathering	Enterprises gathering after talents gathering

Source according to the literature review

important to attract the right people rather than the enterprises in the development of culture industries. It tells us that when enacts policy, the government should attract enterprises and the cultural and creative talents in the same time.

40.4 An Empirical Study on Culture Industry Agglomeration

Currently, the empirical study on culture industry agglomeration mainly adopts qualitative research methods. The key issues include the specific cause of culture industry agglomeration, influencing factors, specific stages and trends of development, and agglomeration effects and scope, etc. These findings are the basis of culture industry agglomeration. However, due to the limitations of qualitative research methods, most researchers mainly base on classic literature review and deduction. They ignore the construction of index system and model of culture industry agglomeration, which leads to insufficient analysis of agglomeration phenomenon and its inherent mechanism. Some scholars have already shifted their focus on quantitative researches. This paper divides the results into the following three perspectives, in order to provide a reference to the in-depth study of this respect.

40.4.1 The Quantitative Analysis of Panel Data

Zhu Hui and Wang Yaoxin select the data of five cities, including Beijing, Shanghai, Guangzhou, Hangzhou and Chongqing from 2003 to 2007. Based on the city panel data, selecting the location of the entropy index LQ, they build the measurement model to analyze agglomeration mechanism based on demand, human resources and policies.

40.4.2 The Statistical Analysis Model Using Regression and Principal Component Analysis

Hou Hanpo, Song Yanjun and Xu Yanqing adopt the principal component model to analyze the dynamic mechanism of Beijing cultural and creative industries agglomeration, and also the role each factor played in the process of agglomeration's development. They find out that generally, enterprises give higher evaluation on competition, hardware facilities, planning guidance and policy support. Competition, trust, and sanctions are more biased towards cultural and environmental factors, while policy support is more biased towards condition of facilities elements.

40.4.3 The Application of System Dynamics Method to the Research on Culture Industry Agglomeration

He Shouchang constructs an open-loop model of creative industries in his doctorial thesis, and introduces the feedback viewpoint in economic cybernetics and system dynamics method to establish the value circulation and value-added closed-loop model for the in-depth analysis of the added value in creative industries. He points out that the development of creative industries cannot be separated from the internal coordination between various elements, and the coordination of a whole creative industry with the external environment. Taking into account the feedback phenomenon of complex systems and its induced circulation value-added factors, the multiplier effect of the creative industries will be more obvious, and the value will increase greatly.

40.5 Conclusion

By the research review of the theories on culture industry agglomeration domestically and internationally, it can conclude that current theoretical studies focus on influencing factors and agglomeration characteristics, with particular emphasis on the theoretical explanations and practical value; Empirical studies focus on dividing the levels and defining the influencing factors of culture industry agglomeration; Domestic studies on agglomeration are more depending on foreign theories; Case studies on agglomeration are limited in cause analyzing and introduction of the features. Thus, scholars are still in the exploration on the culture industry agglomeration's formation and operation mechanism. It has not yet formed a set of mature and supportive theory. These vacancies also demonstrate the significance of this paper.

This paper indicates that the trend of research on culture industry agglomeration theory is as follows: First, deepening the construction of culture industry agglomeration continually, making clear the role government played during the process of gathering, using economic levers to guide the formation and development of agglomeration, and promoting the improvement of the management system; Second, paying more emphasis on the role of culture industry capitalization, diversifying and standardizing of capital, increasing researches on culture industry agglomeration, brand building and urban economic development; Third, the combination of quantitative and qualitative methodology should be adopted in agglomeration studies. Analysis will be unfolded on the causes and inherent mechanism of various levels culture industry agglomeration based on data dynamic quantitative model.

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Chapter 41
The Recognition and Optimization of the Critical Chain

Huan-pei Wang, Bing-nan Liu and Xiao-feng Dong

Abstract Enterprises often face multi-project management challenges at the same time. With the research of critical chain method for single project schedule management being ever-accelerated perfectly, it has the great practical significance application to multi-project management. This paper introduces steps of the critical chain which are used in multi-project management. Nowadays, Priority based multi-project critical chain method may lead to lower priority project's completion time much longer than it completes independently. Considering to this, the paper puts forward the method that considerate with resource constraint and time constraint to recognize the critical chain, and demonstrates this method is feasible.

Keywords Multi-project management · Recognize the critical chain · Resource constraint · Time constraint

41.1 Introduction

At present, project management has been more and more attention and has become an indispensable element in the enterprise management. In 1997, Goldratt (1997), an Israel Eli enterprise management, applied theory of constraints (TOC) to the field of project management, then put forward a new project schedule management method—the Critical Chain Project Management (CCPM).

H. Wang (✉) · B. Liu · X. Dong
Management Collage, Xi'an University of Architecture and Technology, Xi'an, China
e-mail: Wanghuanpei2008@163.com

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41.2 The Critical Chain in Schedule Management

The critical chain is the longest mission chain which considers both the restriction of resources and activity logic complete relationship in the project schedule planning (Kendall 2007). Some activities in the critical chain are determined by theirselves logical order, and others as a consequence of resource allocation adding in the critical chain. It is defined by the activity duration, precedence relations, resource supply and other important factors. The length of critical chain determines the overall project duration.

Critical chain method (CCM) is developed on the basis of the critical path method (CPM) (Tao 2006; Xu 2007). The general implementation steps of the Critical chain method in project management are: (1) Draw a network diagram, finding the chain line; (2) Re-estimate each activity complete time, reducing unnecessary safety time, and avoid estimating the redundant time result in the behavior psychology (student syndrome, Parkinson's Principle); (3) Resolve resource conflicts and identify project's critical chain (Wei et al. 2002). This step is the most important step in critical chain method; (4) Add some time as the compensate part for eliminating safety time which may bring about the schedule risk. According to the risk aggregation theory and Murphy's principle, we can set the corresponding buffer time in the project schedule; (5) Formulate buffer management mechanism. By controlling the various buffers time to monitor the project progress.

41.3 The Critical Chain Method in Multi-Project Management Environment

With the critical chain in a single project schedule management is applied effectively, domestic and foreign scholars focus on the study of the critical chain method in multi-project management in recent years. Yang and Wu (2005) analyzed the direction of the critical chain in multi-project schedule management in his research; In literature of Guo and Yun (2007), Guo et al. (2008) according to the theory of constraints' (TOC) five steps put forward corresponding concrete steps about the critical chain method in project schedule planning, which has a certain guiding significance in the application on the critical chain in project progress management. Steps of critical chain Method implement in multi-project management environment.

41.3.1 Project Priority Determination

Determining Project priority needs to consider the project's important extent for the enterprise, the characteristics of the project, the existing scarcity, the enterprise's overall development planning and so on.

41.3.2 Constraint Resource Determination

Find out process with resource conflict in the multi-project. We named the conflict resources “the constraint resource” or “bottleneck”. Constraint resources can be people, materials or policy.

41.3.3 Critical Chain Identification

Critical chain recognition process is essentially a scheduling problem under Resources constrained (Resources Constrained Project Scheduling Problem, RCPSP). First, recognize the critical path based on the CPM network graph, and then to optimize process which has the resources conflict in network, finally, the longest route is the critical chain.

41.3.4 Security Time Estimation and Various Buffer Settings

In the traditional scheduling method, project planners in order to avoid the effects of uncertain factors in the project, then added some extra time in the task duration, this time is the safety time. A commonly used method to eliminate the safe time is halving method (Cheng et al. 2007).

In multi- project environment, in order to make up the schedule risk at the elimination of safety time, we set the drum buffer (constrained resources) and project buffer. Drum buffer (DB) is arranged in front of the constrained resources to process, to ensure the process which use constraint resource can start on time. Project buffer (PB) is arranged in each single project finally. Common buffer setting methods are Clipping method and Root variance method (Newbold 1998).

41.3.5 Make the Buffer Mechanism to Control the Progress

Make the critical chain buffer mechanism, by monitoring the buffer consumption to control the project schedule.

41.3.6 The Problems of the Critical Chain Method Application in Multi-Project Management

In previous project critical chain management research, identify critical chain principle is to adjust process through deal with constraint resource using in higher priority project to avoid resources conflict. However, based on the project priority progress schedule, it may lead to a lower priority project use more time to complete than its complete independence, ignoring the process itself time constraint. The core processes of individual projects are delayed, leading to add the single project completion time and cost, also does not favor the overall project schedule optimization implementation. Therefore, in this paper, study the basic of previous reference. I consider adding the single project time constraint to the critical chain recognition. Overall project completion time is called "T", the single project completion time is called "Ti", the critical chain recognition need to meet the objective function:

$$\min \mathrm{T} = \sum \mathrm{Tmn}, \mathrm{m} = 1, 2, \ldots, \mathrm{I}; \mathrm{n} = 1, 2, \ldots, \mathrm{N}. \tag{41.1}$$

$$\min \mathrm{Ti} = \sum \mathrm{Tij}, \mathrm{i} = 1, 2, \ldots, \mathrm{I}; \mathrm{j} = 1, 2, \ldots, \mathrm{N}. \tag{41.2}$$

"Tmn" shows spend Tmn time to complete project m'process n in the critical chain. Tij shows spend Tij to complete the project i' the key work j.

41.4 Example Demonstrate the New Critical Chain Recognition Method

A construction enterprise, assume there are two projects (refer with: Fig. 41.1 project 1 and project 2) need to complete at the same time. Then I have used double code network chart to show their schedule, two projects use four resources named A, B, C, D, (D, R) presents this process duration and the resources used. Every resource available capacity is 1 units/day, and can not be stored. Each procedure one day needs 1 units of a resource. A particular resource can only be served a process anytime, avoiding multi-tasking phenomenon.

The first step is to identify critical chain of each single project. Based on the network diagram by using CPM method, to find project 1 critical line is A1 → C1 → E1, considering the project resource conflicts and resource allocation principle, get the critical chain project 1 is B1 → C1 → E1. Similarly, project 2's critical chain is A2 → C2 → D2 → E2. As the following chart show:

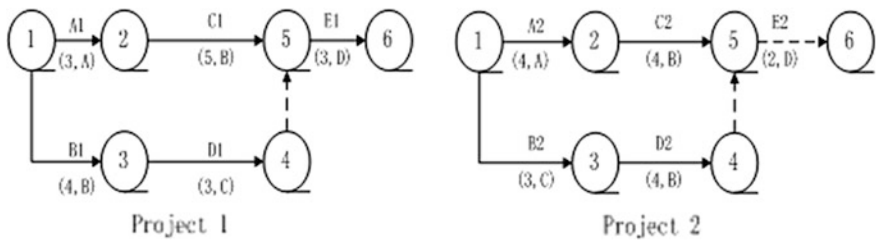

Fig. 41.1 Example of the new critical chain recognition method

The second step is to eliminate the project resource conflict between two projects, getting the project critical chain. The hypothetical project 2 priority is higher than project 1, so when C1 and C2 two different projects need to restrain resource at the same time, in order for C2 → C1. Get multi-project critical chain, as follows (refer with: Fig. 41.2).

Draw the resource constrained multi-project scheduling diagram (Fig. 41.3), calculated the critical chain length at this time which has not eliminate safety time and set the time buffer is 4(B1) + 4(C2) + 5(C1) + 4(D2) + 2(E2) = 19. Project 1 process persistence length is 16, and project 2 process persistence length is 19.

At this time, the priority based resource allocation, when process C1 and C2 meet logic, technology can begin at the same time, but both of them use the

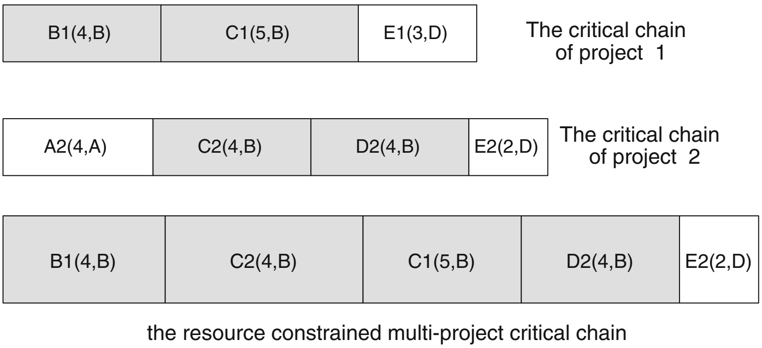

Fig. 41.2 Multi-project critical chain

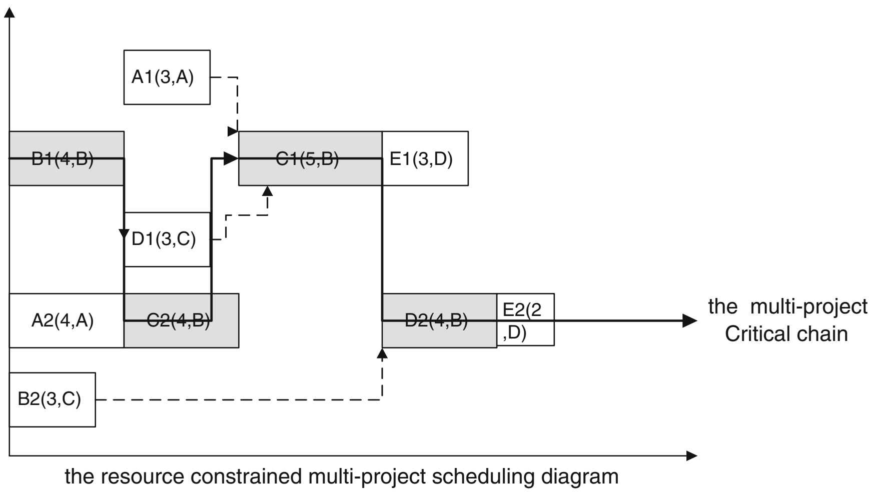

Fig. 41.3 The resource constrained multi-project scheduling diagram

constraint resources, and resource only can be used in a procedure, first select the project 2′ C2, after complete C2 the resources into the lower priority project 1′ C1. When project 2 follow-up process D2 need to use of constrained resources, it has to wait. For a single project, a lot of waiting time exist between immediate predecessor and successor processes. Therefore, it is necessary to consider the project process time constraint when consider the critical chain resource constraints. By adjusting the process sequence to reduce waiting time, and then get a new total critical chain (refer with: Fig. 41.4):

Draw the resource constrained and time constrained multi-project scheduling diagram (refer with: Fig. 41.5), calculated the critical chain length at this time which has not eliminate safety time and set buffer is 4(B1) + 5(C1) + 4(C2) + 4(D2) + 2(E2) = 19, project 1 persistence length is 12, project 2 process persistence length is 16. The total project critical chain length is 19, but the project 1 duration decreased by 4, project 2 duration was reduced by 3, so that with the whole projects are best, a single project scheduling is optimization.

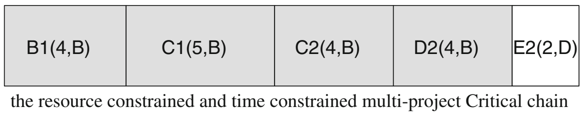

Fig. 41.4 The resource constrained and time constrained multi-project critical chain

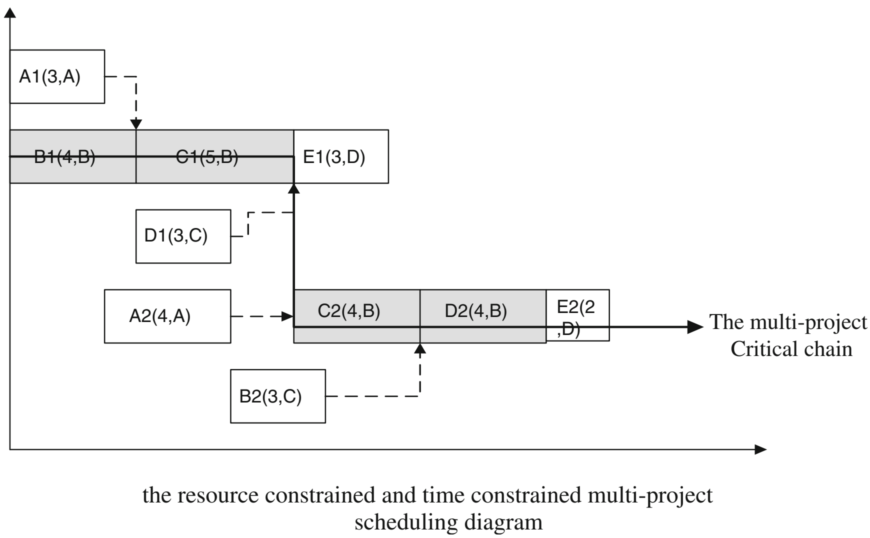

Fig. 41.5 The resource constrained and time constrained multi-project scheduling diagram

41.5 Summary

Based on the priority of resource constrained multi-project critical chain method, through constraint resource to adjust process, calculate the implementation of shortest process time of multi-project at the same time, but may lead to lower priority project completion time much longer than its complete independence, and ignore the single project working procedure time constraints, then it brings different effects to each project. By reducing the process waiting time, adjusting the resource allocation sequence, identifying new critical chain, to guarantee the overall progress of the project the best at the same time and make a single project in multi-project environment more optimization.

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Chapter 42
Using the Network Link Data to Analyze the Status of Cloud Computing

Lu-Cheng Huang and Bo Jiang

Abstract Emerging technologies have a variety of characteristics, this resulting large number of technology analysis methods. With continuous construction of the network infrastructure and expanding of user groups, the network data is increasingly important. Consider the fact that various subjects in real life will show their own behavior in the network, analyzing the link between sites can be helpful for researchers to find the relationship among various subjects, thus accurately determine the stage of technological development and guide the direction of technological development. By studying network link as the data source and analyzing cloud computing, conclusions can be drawn that cloud computing technology is at the stage of transformation from research and development (R&D) to industrialization, the technology is in rapid development phase and so on. The feasibility of network data used for technical analysis is also proved.

Keywords Cloud computing · Internet · Network link

42.1 Introduction

Emerging technologies have a variety of characteristics, this resulting large number of the FTA (Future-Oriented Technology Analysis technology) methods (Technology Futures Analysis Methods Working Group 2004). Many researchers did overall induction of FTA methods, Lan L. Porter introduced 51 kinds of technical analysis

L.-C. Huang (✉) · B. Jiang
Department of Economics and Management, Beijing University of Technology, Beijing, China
e-mail: hlch@bjut.edu.cn

B. Jiang
e-mail: bob621@126.com

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methods, and classified these methods into creative, descriptive, simulation and modeling, expert opinion, value and effect, monitoring and intelligent nature, scenarios, trend analysis, statistical and other 9 major categories, then divided them into qualitative analysis methods rely on experts & knowledge and data-based quantitative analysis (Vanston 2003). Qualitative analysis mainly relies on subjective intuition and experiences of experts or analysts. It's not convincing enough because there is no specific data support of analysis results (Landeta and Barrutia 2011). With the increasing demands on the accuracy of research results, other quantitative FTA technical analysis methods like patent analysis, Bibliometrics method, text mining emerged (Yoon and Park 2007; De Nicola 2009).

However, either the patent data or literature data have limitations in time and population application (Porter and Detampel 1995). We all know that the patent application and patent literature need a relatively long period of audit cycle, and due to higher specialization of the patent and literature, making the most of application groups cannot express their opinions on these two types of materials. But Internet can bridge this gap easily (Kim 2010). Internet as the fastest growing IT technology, bring great convenience to people's lives.

With gradually increase of network transmission speed and bandwidth, expanding of Internet coverage, enriching of all kinds of online applications, popular of blog micro-blog, and the comprehensive construction of WIFI, more and more people can browse the Web at anytime to express their personal point of view (Koppenjan and Klijn 2004). Meanwhile, emerging technologies development trajectory not only led by government but also by the market. We can easily get access to market information from the Internet (Zhu and Porter 2002). Hence, for forecasting technologies, if we only focus on patent and literature data but ignore Internet analysis, this will reduce the reliability of analysis results.

Below are the examples of previous studies: Hewitt drew the conclusion that the main focus of cloud computing system is the integration of information and computing resources on a cloud server (Hewitt 2008), after talking with cloud computing technology experts and academics. Schwiegelshohn and Badia (2010) summarized the rise of cloud computing technology, described the relationship between grid computing technology and cloud computing technology. Vaquero and Rodero-merino (2009) also had a serious discussion on it. Kasravi (2010) used Triz methods on IT technology research, and pointed out that cloud computing technology is currently the most promising technologies in IT.

In this study, we using the network link data to analyze the status of cloud computing, thus prove the feasibility of using the network data.

42.2 Methodology

Various subjects in real life, no matter they are companies, universities, government or nonprofit organizations, all have their own page on network and express their views on the page. Using network link data for technical analysis can be helpful for analysts to find the relationship between various subjects. Furthermore, by analyzing network data can help analysts accurately predict technological development stage and guide the direction. We will use a Web crawler tool for analyzing these sites, the Web crawler is a computer program, and it can extract relevant information from network according to users' need, and then give feedback to the users (van der Lei and Cunningham 2006). Any Internet users like government, enterprises and individuals will make descriptions of part or all reality in the network. Thus, the search engine database can retrieve related sites, the Web crawler can do crawl work with the search tools. As to obtain useful network link information, we need to perform following two steps.

42.2.1 Link Influence Assessment

Network data is voluminous but filled with all kinds of useless data. In order to analyze network links of cloud computing technology, first need to remove useless pages from the network data, extracting valuable web pages. Thelwall (2009) considered that in order to evaluate the influence of the network link, the most basic data is the number of links from a web page or site. This number is a reasonable evaluation of the site value and influence. Similar to reference analysis in the patent analysis, network influence is proportional to the number of links. After collected a series of websites, we need to judge the number of links for each site to find valuable ones, which is the number of site inlinks. Site inlink refers to the other sites link to a particular site. For example, we can get access to the website of the IBM (www.ibm.com) through hyperlinks from Cisco's website (www.cisco.com), and then one site inlink is added for ibm.com. The number of links can be easily obtained from Microsoft Bing (Bing) search engine. The retrieval command is "*linkdomain*", for example, retrieve "*linkdomain:* www.cisco.com" can get all the links for the Cisco website. However, the number of links is not the best data to analyze the network influence, because these data contain not only the number of inlinks, also contains links within the site itself. Those site links cannot demonstrate the importance and value, so they should be removed.

To remove those useless links, we can use another command: command "site" is to list all the pages from a particular domain name. So in Bing we input following retrieve command: "*site:* www.cisco.com", then we can get all the pages from the Cisco website. Then use "*site*" and "*linkdomain*" commands to get the number of inlinks. To retrieve inlinks of Cisco website, enter following command: "*linkdomain:* www.cisco.com *site:* www.cisco.com", this means the number of all links minus the number of links from website itself, which is the inlinks number.

42.2.2 Link Diagram

The relationship among the network links is very complex, but by visualization methods, it can be very intuitive to show the performance of each network link.

The easiest way is the link diagram: circle indicates site, straight lines with arrows indicate the link between sites. In Bing, using retrieve commands "*linkdomain*" and "*site*" to gain information of network links among websites. Retrieve commands: "*linkdomain: A: site B*" can get the number of pages of the site B links to A. For example, to get the number of pages of IBM website link to the Cisco Website, you can use the following command to obtain: "*linkdomain:* www.ibm.com *site:* www.cisco.com".

Crawling links is very time-consuming because its crawling time growth is a positive relationship between the increases of site sample space. To obtain n sites link data, you need to get $n^2 - n$ links. For example, analyzing the link between 100 sites will need to obtain 9,900(100^2 - 100) links. More difficulty is that crawling is limited by the search site access restriction. In this study, in order to obtain link relationships among cloud computing sites, we conducted a total of 50 h data download.

We must note that there are a lot of Internet advertising behaviors, not all links are meaningful when conducting link analysis. So those useless links should be removed, such as A-site and B-site only have advertisement links, then enter retrieval command in Bing search engine: "*linkdomain:* www.ibm.com *site:* www.cisco.com" will only return a small number (usually less than 10). So we need to refine link data by coding program. The pseudo code as follow

```
Initialize i,j;
i=Get(linkdomain:A – site:A);
if(i>100)
   j=Get(inkdomain:Asite:B);
       if(j+i/100>25)
                input B inlink A;
end
```

42.3 Results

42.3.1 Data Acquisition

This study using Bing as a search engine and its Bing API interface, search websites about "Cloud computing" and extract the top 500 sites. Among them, 468 sites are effective. Merging websites which have the same domain names, narrow the number to 402 websites. (For example, merge http://www.cisco.com/web/…/cloud/index.html and http://www.cisco.com/en/…/index.html to www.cisco.com.) Rejecting search engines like Baidu and Google etc., we can get effective websites number is 395. Table 42.1 shows the top 20 inlink numbers before extracting the main domain name.

From Table 42.1, large companies and business sites have a high value among cloud computing sites, such as Intel (www.intel.com), Cisco (at www.cisco.com),

Table 42.1 Top 20 Inlink numbers sites list

Site name	Inlink number
intel.com	662
forbes.com	567
unc.edu	549
umiacs.umd.edu	524
code.google.com	500
vmware.com	479
arxiv.org	479
cisco.com	472
itu.com	440
vi.net	436
nist.gov	431
microsoft.com	428
wikinvest.com	422
guardian.co.uk	386
amd.com	374
blog.csdn.net	373
apple.com	368
ibm.com	347
en.wikipedia.org	339
linux.com	332

Forbes (www.forbes.com), etc. At the same time, the influence of the blog and the knowledge-based websites is also very obvious, such as CSDN community (blog.csdn.net), Wikipedia (en.wikipedia.org) and others. In addition, there are some government sites, such as the American National Standards Institute of Technology (nist.gov), and so on. Next step will be focused on using those inlinks numbers to refine link data, crawling cloud computing related sites. Combine crawling and data processing results, remove website which has no network link, we can get the original link map.

42.3.2 Data Analysis

Cloud computing is the future development direction and revolutionary change in IT industry. Because there is specific definition of cloud computing in Wikipedia and for most sites have a link to the Wikipedia, so first of all, we extract network-centric information of cloud computing and removed the Wikipedia website, result showed in Fig. 42.1.

From Fig. 42.1 we can see that Intel, Microsoft, Apple, Oracle are in the core position of the network link, which shows that each enterprise has been involved in the cloud computing industry, the technology has entered the process of industrialization. Among them, Intel's website, not only is the core of the network but also has the largest number of inlinks. By visiting Intel's website, we can also see

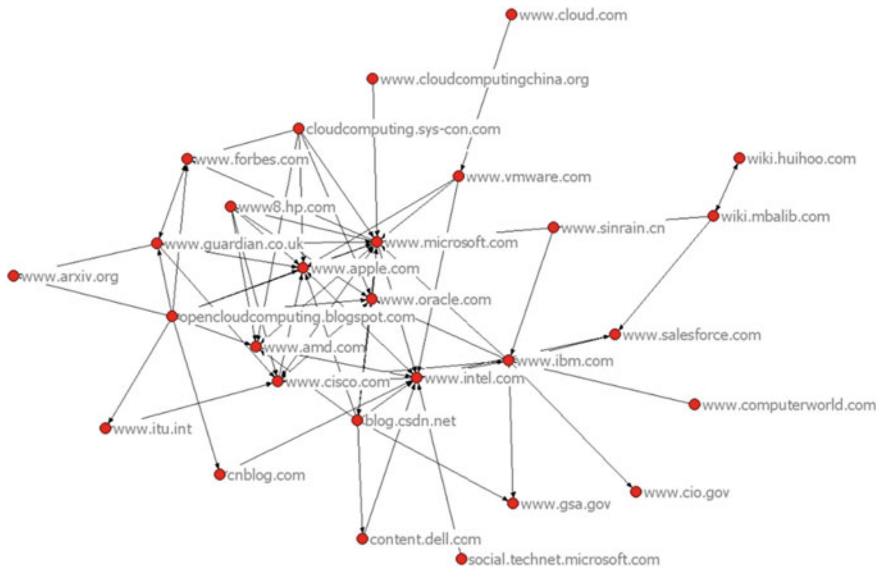

Fig. 42.1 Network link diagram after center extraction

the company as an industry leader is showing its overall strategy and the promotion capacity in the field of cloud computing even out of vendor's role. As in the Open Data Center Alliance, in order to meet user standardization needs, Intel set up the stage and only played as a consultancy role to provide the knowledge level of support. Begin with listening to customer needs, using Intel platform new features, and combining them together, Intel is accelerating the development of the cloud industry as a whole. Other companies also take cloud computing technology as a focus area in strategic development. IBM will bring its own global operations experience and ability of public cloud into China. In cooperation with enterprises and government agencies which have operating public clouds qualification, IBM will build a true sense of China public cloud platform. Moreover, more companies take cloud computing as the last secret weapon, tend to rely on it to change company's present predicament. Despite of the massive layoffs, Cisco network services solutions has its own advantages. In the new era of cloud computing, Cisco still intends to combine their own strengths and strive to seize this excellent opportunity. Apple's new cloud applications "iCloud" can sync email, calendar, photos, contacts, and iTunes library can also help users to find the lost mobile phone or use iWork to create a new document. With "iCloud" cloud service, Apple mobile device with iOS 5 is almost completely independent from computer, all information are on Apple server, even upgrading the system could be achieved by directly connected to the Wi-Fi to update automatically. Vigorous pursuit of the cloud computing technology from those companies has greatly accelerated the industrialization process of cloud computing.

In addition to the company's website, blog sites also take important value, in Fig. 42.2 shows the blog sites link relationship map.

In the Fig. 42.2 we see the blog sites connect with all kinds of business and organizations website, have a very high degree of network-centric. Most of the creators of the blog sites are general Internet users; the behavior of such groups can be a good representative of the prevalence of particular things. Research on blog sites can quickly find the focus of public concern and market acceptance degree. In CSDN blog, search for "cloud computing" returns 12,026 blogs, among them, a large part is about cloud computing technology and application. This shows that cloud-computing technology is not only within current enterprise awareness, but also of concerns from general population. When one technology interests enterprises as well as the market, there will be huge intrinsic motivation to promote technological progress.

In the link map above also contains the U.S. General Services Administration Web site (www.gsa.gov), U.S. National Institute of Standards and Technology Research Institute (www.nist.gov), Chief Information Officer Association (www.cio.gov) and other government websites. Such policy-oriented sites often represent the government's actions. From previous studies, the rise of emerging technologies often supported and led by the government.

Searching "cloud computing" at the U.S. General Services Administration Web site returns a total of 83 articles and the earliest one appeared in 2009. It is found that enterprise began to get involved in cloud computing from 2006, and since 2009 the U.S. government has begun to pay attention to cloud computing, regarding cloud computing as a revolutionary network access technology. September 15 in the same year, Obama government started a GSA cloud storefront: Apps.gov, this

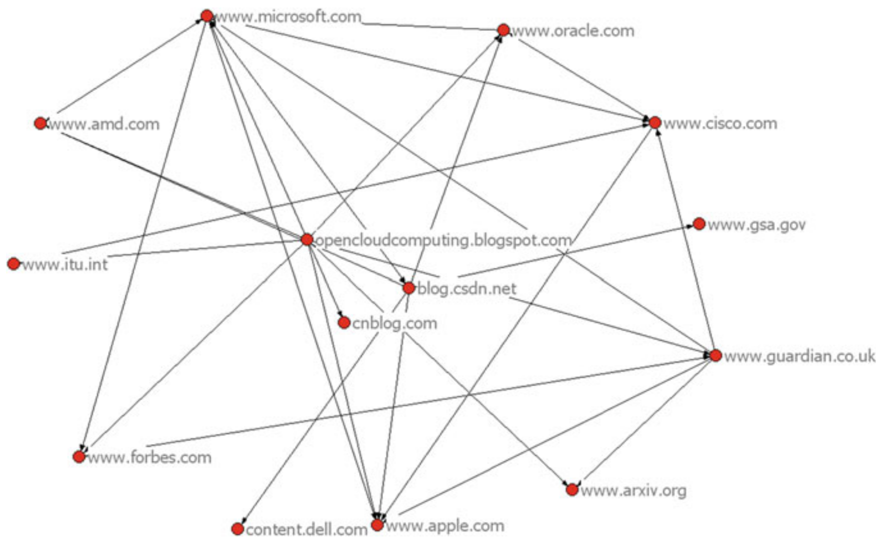

Fig. 42.2 Blog sites link relationship map

shows government promotion of the concept of cloud computing. Retrieving "cloud computing" at the U.S. National Institute of Standards and Technology website can get 8,500 articles, aiming at providing technical guidance and promoting technical standards for effective and safe application in government and industry field. The U.S. National Institute of Standards and Technology has proposed a definition of cloud computing, cloud architecture for the U.S. federal government, the security and deployment strategies, especially focused on making cloud standards, cloud interface, integrated cloud and cloud application interface for U.S. federal government. Retrieve in the Chief Information Officer Association website, can get 8,750 articles about cloud computing. In 2010, first federal government chief information officer Kundera announced the promotion of cloud computing infrastructure plan, called for substantial cuts in government data centers, but transferred them to the commercial and personal cloud computing systems. This is to help government agencies to share services thus improve efficiency by avoiding unnecessary duplication of efforts. In May 2012, the Chief Information Officer Association and the Federal Cloud Standards Committee published the Government effective use of cloud computing contracts. Recent years, the federal government's emphasizes on cloud computing directly heating up the cloud computing market, many cloud computing service providers joined the competition for government procurement orders. In December 2010, Microsoft got the U.S. government's largest ever cloud computing software supply contract to provide Internet-based e-mail and other services to the U.S. Department of Agriculture. Previously, New York City, Minnesota and California also had chosen Microsoft's cloud computing software. Google and IBM are also involved in the project bid. It is because of this policy-oriented, the rapid development of cloud computing technology appears in the United States after 2009.

In addition to enterprises, blogs, and government sites, in the network link map, we also see there is another category of website such as arXiv, although not in the network center, but of great importance. It's a paper photocopies collection site, on which there are 812 articles about cloud computing, provided another analysis perspective of cloud computing technology development. Another example is Wikipedia, provided a detailed description of the cloud computing concept, definition and related technologies, it can help researchers quickly understand cloud computing.

42.4 Conclusion

By studying network link as the data source and analyzing cloud computing can get following conclusions: (a) Cloud computing technology is at the stage of transformation from R&D to industrialization, its technology is in rapid development. (b) Current market has accepted cloud-computing concept, and there are a lot of attentions. (c) Major foreign-invested enterprises (such as Intel, IBM, etc.) attached great importance to the development of cloud computing, corresponding cloud computing market strategies have been provided. (d) U.S. government had earlier concern for cloud computing concept: set up a lot of cloud computing special organization at the same time, stimulus of the promotion of cloud computing concept, all these put them in the leading place. (e) As for our country, the cloud computing technology is not yet reaching the stage of the enterprise-led development. Although many enterprises raise the slogan for the development of cloud computing, no exceptional domestic enterprises have been seen from the network link data. (f) Data shows lack of connection between relevant national government department and domestic enterprises, there may be two reasons: first, lack of contact between domestic small or medium-sized enterprises and government departments; second is relevant departments have not yet achieved decent information management and site constructions.

This study uses network link data to analyze cloud computing technology, the final results prove that it is feasible to use network link data to conduct technical analysis. It provides a new quantitative data sources. However, except for network link data, there are other massive data in Internet (such as: text, audio, video and so on). How to make use of these data has yet to be the further studied.

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Chapter 43
XBRL and Corporate Governance

Kao-hua Yao, Si-pei Xiao and Jing-jing Li

Abstract A study boom on XBRL has been launched globally. Our paper examines the relationship between XBRL disclosure and corporate governance, along with the impact of XBRL on the company's operational capability, using relevant samples of Chinese listed companies. Through performing Logistic regression, we find that most variables are not significant. However, in the study in depth, we use the method of Forward in Logistic regression to examine the effect of the variables one by one. And the result shows that removing "Gov" greatly reduces the overall effect of the model. So we document the link between corporate governance and financial statements disclosed in the form of XBRL, which also have positive correlation with the company size. We hope the conclusions in this article will help and inspire the application of XBRL in China.

Keywords Corporate governance · Information disclosure · Information asymmetry · XBRL

43.1 Introduction

With multi-platform operation of enterprises today, the conversion of information between different forms is difficult, which hinders the exchange of information. It is more difficult for decision-makers to grasp the overall situation and make the best decisions in complex and changing environment. The old forms of information disclosure have been outdated and people now have increasingly strong demand for convertible information, which leads to the generation of XBRL. XBRL, which deprives from XML, is a standardized language designed to prepare the business reports, disclose the financial information and improve the efficiency

K. Yao (✉) · S. Xiao · J. Li
School of Business Administration, Hunan University, Changsha, China
e-mail: 295886208@qq.com

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of information utilization. It is timely, accurate, efficient and economical while dealing with data, which, in some degree, helps to reduce the information asymmetry resulting from the inconvertibility of different forms of information.

SEC final rule 33-8529 was released on March 16, 2005, which requires disclosing financial reports in XBRL form on the EDGAR system. This rule encourages SEC members to voluntarily use XBRL in financial disclosure. In cases not imposed by law, voluntary disclosure in such advanced forms of XBRL can convey positive signals to investors, such as high information transparency, good operating condition, higher corporate governance standards, and so on. It is hot to use XBRL in China. Making it clear whether XBRL has relationship with corporate government is helpful for decision-making of investors' and the use in Chinese market. That's why we do this research.

43.2 Background and Prior Studies

Diamond (1985) document that, in order to increase the difficulty for investors to get private information and reduce the degree of information asymmetry, companies should improve the quality of information disclosure to the extent of timely dissemination of substantive information. Hunton (2003) examines the inevitability of XBRL in depth in his study. He argues that, on the cost hand, the main cost of continuous reporting is the cost for relevant facilities and the implementation of information exchange technology. When the XBRL technology is comprehensive universal, the marginal cost for continuous reporting will gradually drop and even be able to be neglected. On the benefit hand, XBRL enables us to supply continuous reporting, which helps decision-makers reduce the information risks and other information asymmetry problems. Hodge et al. (2004) also think so. These scholars who explain the rationality and inevitability of XBRL provide a theoretical basis for related researches and improve the research framework.

Many scholars analyze the advantages of XBRL from different perspectives. Peng (2007) points out the strategy advantage of XBRL in its research. First, it can deal with enterprise group financial information fast and precisely. Second, it is convenient for information exchange. Third, XBRL has the potential to be the universal language for financial reports. XBRL can realize the information exchange across different systems and platforms without worrying about the problem of being incompatible, which largely improves the efficiency. Debreceny and Gray (2001, 2005) argues that the most critical role of XBRL is that XBRL can realize free conversion of different languages by defining. Chen et al. (2006) explains that XBRL promotes the regulation of risk information disclosure of listed companies and helps save the information disclosing cost. Russo (1998) has documented in his research that: relative to plain text, information in the form of tables can enhance the consumers' decision-making ability. According to his research, XBRL, displayed in a tabular format, does enhance the decision-making capability of information users. Zhang and Gao (2007) argues in their research that, in-depth application of XBRL will have major impacts on the audit community (Zhang and Yang 2004). With the widespread of XBRL, continuous audit of information systems will become possible. In view of the role of auditing in improving the accuracy and credibility of financial information, XBRL naturally plays an important role in reducing information asymmetry and helping stakeholders make optimal decisions based on accurate financial information.

The above scholars document the advantages of XBRL from different perspectives using the method of normative research, which supply theoretical guidance for the practical application of XBRL. But there is a limited number of empirical researches on the application situation of XBRL.

Pinsker (2003) used investigation questionnaire to perform empirical research, limiting his investigation objects to accountants and auditors to study whether XBRL makes the financial information more accurate and effective. The results show that most of the accountants and auditors investigated hold skepticism or negative attitude; at the same time, most people who fill out the questionnaires do not think XBRL can improve the effectiveness of financial information due to lack of XBRL knowledge and related application experience. In domestic, Zhuang Minglai (2007) select 49 listed companies in Shanghai stock market, and analyze whether application of XBRL has a positive effect on abnormal stock return rate. However, the result is not significant, which shows that the application effect of XBRL in China is not obvious. It can be seen from the current literature that scholars tend to analyze the benefits of XBRL from the theoretical point of view and very few people embark on the empirical studies. What's more, existing empirical studies show poor effectiveness of XBRL application, which is apparently different from normative analyses. However, on the development point of view, we know that XBRL is a new thing, which will finally be mature and even recessionary only after the germination and growth. In the early stage of XBRL application, because of the lack of information and the much friction of adaptation, it is possible that the effect is not obvious which leads to the empirical researches being not significant. Now the data we can take advantage of has accumulated to a certain amount. Coupled with appropriate empirical methods, we may get a different result. In view of the good momentum of XBRL application in domestic, with the probability of signal effect in its early application, we are very interested in using empirical methods to study the relationship between XBRL and corporate governance, hoping to benefit the investors' decision-making and the promotion of XBRL in China.

43.3 Methodology

43.3.1 Hypotheses

One of the purposes of XBRL is to reduce the information asymmetry. Therefore, our initial assumptions: companies adopting XBRL disclosure are better than those of none adoption in financial reporting transparency. We try to prove that companies with XBRL disclosure of reports are more capable of corporate governance. Using the study of Lang and Lundholm (1993), Wallace et al. (1994), Camfferman and Cooke (2002), and Alsaeed (2005) for reference, and considering firm characteristics as proxies for the degree of variation related to firm voluntary disclosure, we form our independent variables and classify them into three categories:

1. Operating-capacity-related variables: liquidity ratio, net profit margin and Roe.
2. Market-related variables: audit type, the type of company.
3. Structure-related variables: leverage ratio, company size.

Enterprise liquidity represents the short-term debt paying ability. In the existing literature, there is no unitive conclusion about the enterprise liquidity and the statements information disclosure. For example, Belkaoui and Kahl (1978) find that there is no associated relationship between them. However, Wallace et al. (1994) documents the negative correlation and Camfferman and Cooke (2002) document the positive one. Different scholars draw contradictory conclusions. At home, the researches about XBRL remain in the theoretic stage, and there is nearly no empirical exam. Based on the theoretic conclusion that XBRL can help to find the creditors and the debtors of a debt through marked information, we believe enterprises with XBRL have better liquidity than those without XBRL. So we build hypothesis 1:

Hypothesis 1: The liquidity of the companies using XBRL is better than that of those companies without XBRL.

Lang and Lundholm (1993) study the relationship between the information disclosure degree and the profitability, and no correlation has been found. Camfferman and Cooke (2002) take the English market for samples and find the negative correlation between the net profit rate and the statements information disclosure degree. However, Singhvi and Desai (1976) conclude from their research that the enterprises who supply extra information for their investors have relative higher profitability. We believe enterprises with good financial situation would like to disclose their information better. XBRL is a kind of technology that help the users to disclose the information, so enterprises with better financial situation tend to disclose their financial statements in the form of XBRL. Then we build hypothesis 2 and 3:

Hypothesis 2: Companies with XBRL have higher net profits than those without XBRL.
Hypothesis 3: Companies with XBRL have a higher rate of return on equity.

The existing accounting firms have been divided into 2 parts: the Big 4 and the others. The Big 4 perform their businesses all around the world, while the others limited the work mostly in their origin countries. Prior literatures give contradictory conclusions about the relationship between the audit type and the information disclosure degree. Camfferman and Cooke (2002) find a positive correlation, while

Naser (2003) take the Hong Kong enterprises for samples and draw a negative conclusion.

At present, the clients of the Big 4 are all XBRL members. So we have reasons to infer that the Big 4 encourage their clients to take XBRL to disclose the financial statements, which is convenient for the connection with the international accounting standards and lays a foundation for the early realization of continuous reporting. It's worth noting that, as one of the Big 4, PWC, who is one of the main sponsors, especially hope that its clients can adapt themselves to XBRL. Of course the left 3 accounting firms are also following the system. Most of the clients of Big 4 are large global enterprises, who also hope to improve the information transparency and fulfill their social responsibility. American enterprises, who obey the Sarbanes–Oxley Act, take the XBRL to disclose their financial statements (which is especially emphasized by the SEC). In Chinese market, the CSRC issued the final regulations about XBRL and began to advocate XBRL in 2009. In this market with good environment, we believe the clients of Big 4 would take XBRL to disclose information. So we build hypothesis 4:

Hypothesis 4: Companies who hire the Big 4 probably disclose their financial information in the form of XBRL.

In an efficient market, if a firm increase its liabilities, the creditors will attach more terms in their contracts relative to the firms with few or even no public debts. Jensen and Meckling (1971) suggest that firms with high debts can alleviate the associated monitoring costs for creditors by achieving more comprehensive levels of disclosure. That is the enterprises with high financial leverage tend to disclose more information to reduce the creditors anxiety about their ability to repay the debts in the future. So we build hypothesis 5:

Hypothesis 5: Companies with high financial leverage are more likely to use XBRL financial information.

Many literatures document that there exists significant positive correlation between the information disclosure degree and the firm size. Camfferman and Cooke (2002) write, "size has been found to be a very significant variable in most studies with a positive association between size and the extent of disclosure." Larger firms tend to disclose more financial information with the following 3 reasons: first, more information disclosure has positive effect on the operating costs and the ability to get new capital sources in the future development; second, relative to small firms, larger ones draw more attention from the public, which compel them to improve the degree of information disclosure; third, for the larger firms, whose business is more complex than the small ones, they have more financial information to collect and analyze, so they tend to take new technologies like XBRL to disclose information. So, we build hypothesis 6:

Hypothesis 6: Big companies tend to disclose their financial information through the new technology XBRL.

43.3.2 Sample Selection and Data Sources

Shanghai Stock Exchange (SSE) announced the SSE Corporate Governance Sector selection methods. The samples from the SSE 180 Corporate Governance Sector are "elites", whose corporate governance is regarded as being effective by the public and the experts.

This article selected these 100 companies as samples, and divided them into two groups according to whether the company uses XBRL or not. Taking the particularities of financial industry into account, we excluded banks and other financial companies from the samples. Our data is from the CSMAR transaction database provided by the Shenzhen Guo Taian Information Technology Limited Company.

43.4 Results

43.4.1 Measure of Corporate Governance

In the existing literatures, numbers of proxies for corporate governance can be found. As the specific indicators of the corporate governance index are not open to the public, we were going to use the methods taken by many scholars abroad and domestic for reference. Finally we chose the method used by Bai and Liu (2005) and Zhao (2006) to study the companies' corporate governance standards, as the basis for empirical tests done next. According to Tables 43.1 and 43.2, the corporate governance evaluation system was as the following (Table 43.3): $Gov = 0.039x_1 - 0.065x_2 + 0.085x_3 + 0.119x_4 + 0.4x_5 + 0.319x_6 + 0.0574x_7$.

43.4.2 Logistic Regression Testing

Tables 43.4 and 43.5 shows that while comparing the two groups of samples, the Gov of companies with XBRL is much higher than that of companies without XBRL. First, we examined the sample models, finding that Chi Square is 14.962,

Table 43.1 Descriptive statistics

	Mean	Std. deviation	Analysis N
Whether the state-controlled	0.14	0.349	100
CEO serves as the board of directors	0.06	0.239	100
Proportion of external directors	0.38	0.083	100
The largest shareholder	44.2746	18.03224	100
Second to ten of the shareholding	19.8169	14.67050	100
Whether there is a parent company	0.75	0.435	100
In other markets listing	0.30	0.461	100

Table 43.2 Component score coefficient matrix

	Component			
	1	2	3	4
Whether the state-controlled	0.039	−0.052	0.649	−0.045
CEO serves as the board of directors	−0.065	−0.141	0.030	0.851
Proportion of external directors	0.085	0.199	0.437	0.280
The largest shareholder	0.119	0.710	0.028	−0.161
Second to ten of the shareholding	0.400	−0.391	0.158	−0.112
Whether there is a parent company	0.319	0.210	−0.353	0.256
In other markets listing	0.574	0.132	0.057	−0.062

Extraction method: Principal component analysis
Rotation method: Varimax with Kaiser normalization
Component scores

Table 43.3 Descriptive statistics

	Component			
	1	2	3	4
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Whether there is a parent company	0.319	0.210	−0.353	0.256
In other markets listing	0.574	0.132	0.057	−0.062

Table 43.4 Variables in the equation

	B	S.E.	Wald	df	Sig.	Exp(B)
Gov	0.405	0.483	0.703	1	0.402	1.499
CurrentRatio	1.346	0.715	3.548	1	0.060	3.843
NetProfit	−3.767	4.470	0.710	1	0.399	0.023
ROE	−4.715	4.341	1.180	1	0.277	0.009
Big4	0−0.322	0.952	0.115	1	0.735	0.724
Leverage	2.236	2.567	0.759	1	0.384	9.358
Assets	0.000	0.000	1.274	1	0.259	1.000
Constant	−2.527	2.235	1.279	1	0.258	0.080

and p value is 0.036, with Cox and Snell $R^2(0.312)$ and $Nagel\ker ke\ R^2(0.416)$, which indicate that our sample model fits very well.

Next, we investigated the logical equations. After performing Logistic regression, we found that most variables were not significant. In order to study in depth, we used the method of Forward in Logistic regression to examine the effect of the variables one by one.

After gradually removing variables and observing their impact on the model, we found that removing "Gov" greatly reduced the overall effect of the model

Table 43.5 Coefficients (Dependent variable: Gov)

Model		Unstandardized coefficients		Standardized coefficients	t	Sig.
		B	Std. error	Beta		
1	(Constant)	−0.574	0.964		−0.596	0.559
	Current ratio	0.004	0.108	0.010	0.036	0.972
	Net profit	1.346	3.584	0.112	0.376	0.712
	ROE	−0.794	3.488	−0.064	−0.228	0.822
	Big4	0.599	0.452	0.275	1.325	0.202
	Leverage	0.612	1.264	0.149	0.484	0.634
	Assets	7.950 E–13	0.000	0.414	1.859	0.039

Model Gov = $\beta_1 + \beta_2$ Current Ratio + β_3 Net Profit + β_4 ROE + β_5 Big4 + β_6 Leverage + β_7 Assets

($p < 0.003$). However, the obvious effect wasn't found when we removed the other variables. Thus, we concluded that whether to use XBRL to disclose information do have an impact on corporate governance.

Relying solely on a Logistic regression to derive the conclusion seems rather far-fetched. To go further to verify our hypothesis, this article formed a new group of companies with XBRL to reform a new regression model with the corporate governance variable as the dependent variable.

According to the new Logistic regression results, we concluded as follows:

1. regression results clearly show that the relationships between the flow rate, the rate of return on equity of enterprises, the net profit margin and the corporate governance are not significant, just like what Camfferman and Cooke (2002) have found in the United Kingdom market about the relationship between the degree of corporate information disclosure and the liquidity. So refuse to hypothesis 1, 2, 3.
2. whether the company is audited by the big 4 is not significant ($p = 0.202$), which is different from the research of Cooke and Camfferman (2002), who found that the relationship between being audited by the Big 6 and the level of information disclosure is significant. Things are obvious different in China, so we refuse to hypothesis 4.
3. financial leverage is also found to be insignificant ($p = 0.634$). However, the size of company is found to be positive significant. So we refuse hypothesis 5,but accept hypothesis 6.

43.5 Conclusion and Limitation

This paper analyzed the relationship between XBRL disclose of financial information and good corporate governance. The empirical results indicate a positive correlation. In addition, we found a relationship between the company size and the use of XBRL. After further analyzing the results, we think that the large companies with good governance try to transfer positive signals to investors through the use the XBRL, to show their perfect management and financial transparency, which helps them win the trust of investors and gain more resources.

Because this article uses the SSE 180 corporate governance samples, the limitation of this article is that the sample size is too small. In view of XBRL's young age in the Chinese market, we strongly hope that in the near future we could use a larger sample to research again if the information sources are sufficient. Another limitation is that we use company governance index which is designed by ourselves. It is possible that the index we use for evaluating the corporate governance doesn't achieve the depth in some degree. If we could use the corporate governance data of Nankai Business Review, the conclusion we drew from the research would be more accurate.

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Chapter 44
Independent Innovation and Equity Finance: Empirical Analysis on Small and Medium-Sized Enterprises

Wei Wei

Abstract We use the small and medium-sized enterprises data of Hebei province to analyze the correlation of the independent innovation and equity finance. The result shows that a higher equity ratio is conductive to a higher R&D intensity. Equity may be more important for young companies which have to rely on original equity investment of their owners since they have not yet accumulated retained earnings and can rely less on bank financing.

Keywords Equity finance · Independent innovation · Small and medium-sized enterprises

44.1 Instruction

The innovative activity of enterprises is a driving force for economic growth. Consumers benefit from a greater choice of goods and services, and enterprises benefit from the creation of another markets and making a profit chances. At the macroeconomic level, independent innovations accelerate structural adjustment to make new viable parts and play an important part for the creation of jobs posts. Although large enterprises spend a high share of the total R&D expenditure, small and medium-sized companies are also important partners in the innovation process. In recent years, companies pay more and more attention to independent innovation. The purpose of this paper is to provide an analysis of the equity capital available affects their R&D activity.

W. Wei (✉)
School of Management, Hebei University of Technology, Tianjin 300401, China
e-mail: weihappy2000@163.com

W. Wei
The People's Bank of China Shijiazhuang Central Sub-branch, Shijiazhuang 050000, China

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44.2 Theoretical Background

Companies can choose between several broad types of financing: internal financing, external debt and external equity. It is difficult to get money from extern financing to R&D project. One is the high uncertainty of the innovation project. The other is that the quality of the project which need not only the technology information but also the detail of the R&D is secret which will give birth to asymmetry to the investors.

Evidence from many countries shows that the small and medium-sized enterprise rely mostly on internal financing. If they seek external financing, they preferred bank loans. Less than 1 % of the investigated companies are found by Ou and Haynes (2006). The peculiar characteristics of R&D projects make debt financing in specially difficulty. Banks get the interest rate and they can't share the success which independent innovation reaches. So they are more concerned with the probability of failure when calculating the loan. Furthermore, R&D items often don't include assets that will be used as collateral. The costs of the independent innovation persons take an important part in the R&D payout. R&D activity therefore needs collateral.

Younger enterprises have age problems with get bank loans. The banks will make use of relationship lending to mitigate problems of asymmetric information to make good decision. Since young enterprises start without such a record, banks will be not pleasure to offer them loans. Fritsch document the probabilities for going out of business for German companies, finding a decrease in the probability of exit with firm age. After 10 years only 46 % of the companies are still in business and about 37 % of the start-ups in services. There are several possible reasons for the higher exit rates of young companies, such as inexperienced management, unfixed customer and matters making the product in the market.

Venture capital is the "smart capital" with the company in choosing the projects, which in a certain extent enhance the possibility of project. This characteristic combined with participation in the upside potential of project in the upside potential of project makes venture capital more suitable for the financing of R&D than bank loans. The share of venture capital financing is very limited. Venture capitalists don't like to finance technology based companies at the initial stage. Murray and Lott (1995) find that the UK venture capitalists setup more strict criteria for technology projects than nontechnology projects. In addition, Scott (2000) finds that owners are unwilling to losing control of venture capitalists. Even in the countries which have a well developed venture capital market, some owners will find the cost of using this financing is too high. It can be acknowledge additional owners to the company too. This route of financing also means that existing owners will lose part of their control. In this paper we consider in the R&D enterprise, external debt play a most important part in the debt, particulate to the developing enterprise, because they have no chance to subsistence income. The empirical analyze mainly research the correlation of the equity finance and independent innovation. The result shows that a higher equity ratio is conductive to a higher R&D intensity.

The small and medium-size technology enterprise is one developed based on a originally technology. In Stat we usually use the R&D expense account for sell to define it. The high science and technology is the R&D expense account for sell mainly 7 %. The figure of prep high science and technology is 2–5 %.In American the science and technology enterprise is defined innovation enterprise. The science and technology ministry and the finance ministry define the high science and technology in the science and technology enterprise fund regulate is that the employee is not more than 500, the employee who have school experience above acad. is not less than 30 %. The employee who research straight occupy 30 % of the total. And the R&D expense in every year is not less than 3 % of the sale. Enterprise in this paper is what we say above.

44.3 Related Literature

This paper focuses on the influence of the financial on the R&D activity. The authors restrict their sample to companies with minimum positive R&D expenditure and do not use facilities to establish the direction of consequence. And the sample doesn't include companies without R&D and without continuous R&D activity. Bhagat and Welch (1995) do that they compare the influence of leverage on R&D intensity across countries for listed enterprises using a VAR approach. Jordan et al. (1998) find that companies with an innovation strategy have lower leverage. And companies with a higher capital intensity have higher leverage. Bah and Dumontier (2001) find lower leverage for R&D intensive enterprises in the USA, UK, Japan and countries in Europe. Chiao (2002) finds a negative effect of debt on R&D intensity in science-based industries and a positive influence for companies in nonscience-based industries. Cassar (2004) finds that the share of capital assets has a positive relationship with long-term leverage. Czarnitzki and Kraft (2004) recognize a negative relation between leverage and innovation output measured by patents. Aghion et al. (2004) find higher leverage for companies with R&D activity and that leverage decreases with increasing R&D intensity. Hyytinen and Pajarinen (2005) research the determinants of leverage for small, unlisted companies. In contrast, Mac An Bhaird and Lucey (2006) find that their is no relationship between R&D intensity and short- and long-term leverage for Irish small and medium size enterprises.

The influence of financial constraints on the investment behaviour of companies also exists. For the US, a positive and significant relationship between R&D expenditures and cash-flow is found (Hall 1992). Egeln et al. (1997) find an inverse U-shaped relationship between company age and whether financial restrictions are important obstacles to innovation activities of German companies. The restrictions are most important for companies at the age of 5–10 years. Bond et al. (2007) find no influence of cash flow on R&D expenditures of German companies, whereas cash flow influences whether UK companies perform R&D. There are therefore differences between companies in bank-based and market-based systems.

The literature in China is mainly on the finance support to the independent innovation of small and medium-size, VC invest mode, second market development etc. And there is no research on the equity and independent innovation. This paper will focus on the correlation of the equity finance and independent innovation which have important meaning to how the finance structure supports independent innovation.

44.4 Data and Variable Enactment

This paper research the small and medium-size R&D enterprises 2010 in Hebei province. We take in account scale, structure, financial state in Data enactment. The factor which impact R&D is plenty. We use R&D intensity as the dependent variables, use the equity ratio, the cost of capital, number of employee, company age, industry factor as explanatory variable which can be see in Table 44.1. We use logistic regression manner to analysis.

We construct a logistic regression and use SPSS to analysis how these factors affect R&D. The model is as follow:

$$RDI = \mathrm{c} + \mathrm{a}^1 ER + \mathrm{a}^2 COC + \mathrm{a}^3 NOE + \mathrm{a}^4 CA + \mathrm{a}^5 IF + \varepsilon$$

44.5 Descriptive Statistics

In order to understand the finance of small and medium-size enterprise we research whether or not there is difference in structure between innovation and nontechnology innovation. The descriptive statistics are provided in Table 44.2. A notable difference is that independent innovation enterprises have more advantage in scale. For example the average of number in independent innovation is nearly twice of

Table 44.1 Variable define

Variable	Variable symbol	Variable explain
R&D intensity	RDI	R&D expense account for sale
Equity ratio	ER	Data of 2010
Cost of capital	COC	Data of 2010
Number of employee	NOE	Six group:=1, <9; =2, 10–19; =3, 20–49; =4, 50–99; =5, >100
Company age	CA	=0, less than 8 years
Industry factor		=1, more than 8 years
	IF	=1, manufacturing industry; =2, merchant industry; =3, service industry; =4, architecture industry

Table 44.2 The contrast between independent innovation and non independent innovation

	Mean			Median	
Variable	R&D	No R&D	Sig. lev. difference (%)	R&D	No R&D
Equity ratio (%)	22.8	20.3	<1***	18	13
Company scale (thousand yuan)	8045	5985	<1***	3100	1450
Equity capital (thousand yuan)	2085	1221	<1***	423	168
Number of employees	59	31.7	<1***	35	15
Company ages (year)	32.2	31.5	73	13	13
Equity per owner (thousand yuan)	1026	536	<1***	235	100
Number of owners	1.96	1.69	<1***	2	1

* Correlation is significant at the 0.05 level (2-tailed)
** Correlation is significant at the 0.01 level (2-tailed)
*** Correlation is significant at the 0.1 level (2-tailed)

none independent innovation. And the total assets are more. The difference in the company can be ignored.

The difference between R&D and non R&D company is very obvious. R&D is inclined to equity capital. We can find the equity ratio is 2.5 % more than non R&D. And they are significant at the 1 % level. The equity capital of R&D is obviously higher than non R&D. The equity per owner is 10.26 million and non R&D is 5.36 million. In order to keep the abundance of capital, company will get money from shareholder. Equity per owner and number of owners are significant at the 1 % level.

Table 44.3 shows the descriptive statistics of variables.

From Table 44.3 the equity ratio mean is 20.9 %. The mean number of employee is 59. The mean company ages is 0.36. And Std dev is 0.51. Because we use the dummy variable we find small and medium-size enterprise is in the developing time. The mean industry is 1.8, std dev is 1.17. There are 26 % company engage in R&D, 31 % manufacturing industry, 28 % merchant industry, 23 %service industry, 18 % architecture industry. The mean R&D intensity is 2.82 and std dev is 7.58. We can find the R&D intensity is low, and the difference between the R&D enterprise and non R&D is big.

44.6 The Correlation Analysis

We use person manner to analyze the correlation between the variables. Table 44.4 shows the result.

Table 44.3 Descriptive statistics

Variable	Minimum	Maximum	Median	Mean	Std. dev.
Equity ratio (%)	1	100	15	20.9	21.1
Cost of capital (%)	2.1	15.6	9.4	7.9	1.53
Number of employee	5	948	35	59	82
Company ages	0	1	0	0.36	0.51
Industry	1	4	2	1.8	1.17
R&D intensity (%)	0.53	70	5.6	2.82	7.58

Table 44.4 The result of the correlation of variables

Variable		ER	COC	NOE	CA	IF	RDI
ER	Pearson correlation Sig.(2-tailed) N	1	0.021	0.022	0.131	0.315	0.316
			0.260	0.059	0.232	0.087	0.089
		487	487	487	487	487	487
COC	Pearson correlation Sig.(2-tailed) N		1	0.251	0.139	0.279	0.152
				0.362	0.247	0.184	0.253
			487	487	487	487	487
NOE	Pearson correlation Sig.(2-tailed) N			1	0.011	-0.137	0.019
					0.607	0.221	0.324
				487	487	487	487
CA	Pearson correlation Sig.(2-tailed) N				1	0.165	0.102
						0.115	0.047
					487	487	487
IF	Pearson correlation Sig.(2-tailed) N					1	0.190
							0.354
						487	487
RDI	Pearson correlation Sig.(2-tailed) N						1
							487

*Correlation is significant at the 0.05 level (2-tailed)
**Correlation is significant at the 0.01 level (2-tailed)

The correlation between ER and RDI is 0.316, and the significant level is 0.089 which we can find strong positive correlation. Most of small and medium-size enterprise is in the developing time. The sale goes up quickly, and the R&D investment goes up too. So the RDI rises. The correlation between COC and RDI is 0.152, and the significant level is 0.253 which we can find the weak correlation. Maybe now, the COC is not the determine cause. The correlation value between NOE and RDI is 0.019, and the significant level is 0.324 which we can find weak correlation between NOE and RDI. The person increment can't promote the R&D. The correlation between CA and RDI is 0.102, and the significant level is 0.047 in which we can find strong positive correlation. The company age's increment promotes it increase it's capital which will have more capital to spend in R&D. The correlation between IF and RDI is 0.190 and the significant level is 0.354 which prove the influence of IF to RDI is very weak.

44.7 Regress Analysis

We use regress analysis between the factor and RDI (Table 44.5).

The R-correlation value is 0.792 which shows that the factors we choose have strong relation with R&D.R-squared is 0.627, which shows regress equation can explain the crucial R&D expenditure factor from the factor we choose. F value is

Table 44.5 Model parameter

Model	R	R-squared	Adjusted R-squared	Std. Error	F value	The marked probability of F
RDI	0.792	0.627	0.613	0.085	58.124	0.000

58.124, and the marked probability of F is 0.000, which shows regress equation past the test the significant level at 0.01.

Table 44.6 shows the Sig. t value of ER is 0.000, which shows that ER have obvious difference with 0. It shows the equity capital have influence on RDI. The Sig. t value of COC is 0.131 which shows that COC don't have difference with 0. It shows that COC don't have obvious difference with RDI. The Sig. t value of NOE is 0.003 which shows it have obvious difference with 0. It shows the more business enterprise number, the more technique innovation activity. And the rate of large-scale enterprise carry on technique innovation is higher, while the R&D intensity is smaller, maybe because the small and medium size enterprise is in the growth process. The income gets significant growth. The technique innovation expenditure of growth fails to catch up with income growth. The Sig. t value of CA is 0.001 which shows it have obvious difference with 0. And equity ratio has little influence to management time. But to younger enterprise the influence is obvious. Although the small and medium size enterprise has get income wealth, its technique innovation intension will not be strengthened.

Regress result shows if the enterprise has ample funds to assure technique innovation success, governors are more incline to carry on a technique innovation items. For higher R&D enterprise, equity capital may is more importance. So compare to other management item technique innovation will face the higher risk. And it is more difficult to acquire an exterior funds support. If technique innovation have the smaller weight in the business, the enterprise never need to keep the higher equity ratio for R&D to provide funds. Enterprise which want to obtain loan, its whole risk level should reach at the bank accept level or provide for enough guarantee to reduce bank risk.

For younger enterprise the influence of the equity ratio upon the management time is bigger than the longer enterprise. The main reason is the longer enterprise has already get income accumulation in the management. Their funds are more abundant, while the younger enterprise didn't yet experience the originality and it

Table 44.6 Regress coefficient and the marketed test result

Variable	Coefficient	Std. Error	t-Statistic	Sig
Constant	−0.007	0.115	−0.063	0.000
ER	0.351	0.030	1.164	0.000
COC	0.009	0.032	0.324	0.131
NOE	−0.530	0.007	1.693	0.003
CA	−0.634	0.051	2.285	0.001
IF	0.624	0.049	1.884	0.025

can only depend on proprietor investment. The longer business enterprise can provide some guarantee. They can acquire a parts of technique innovation funds from bank. The younger business enterprise can hardly acquire a technique through exterior margin innovation funds, while they mostly depend on themselves. But our analysis didn't show whether business enterprise will be been limited by equity capital. If the investor can't continue increase investment because the funds are limited, the enterprise may lead to obtain equity capital from the exterior investor. But it is difficult to find a enterprise which would like to invest the risk enterprise and accord with investor condition or a person. Even they can obtain an exterior ownership of share. Because they may lose enterprise part control power, the current proprietor may not adopt this kind of way.

44.8 Conclusion

In this paper we study the relationship between the capital structure of small and medium size enterprises and their R&D activities. We find positive related relation between equity ratio and technique innovation intensity. And this influence for younger enterprise is more obvious. The more the equity ratio is higher the more R&D intensity is stronger. Only the owners make sure to own enough of the funds to support R&D activity and obtain success. They probably would carry on the technique innovation. For the younger enterprises, they have no accumulation to subsist income, and don't depend on a bank loan. But they only can depend on proprietor originality capital. The enterprises' needs of technique innovation funds are small which don't usually engage in technique innovation. There is no need to keep a higher ownership of a share margin level. But for technique innovation enterprise whose RDI is bigger such as high technology enterprise, the technique innovation item bank loan is difficult. The equity capital need is big, so these enterprises depend more on environment what is more easy to obtain exterior capital.

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Chapter 45
A Explanatory Model of Public Acceptance for Nuclear Power Technology: From Low-Carbon Perspective

Yuan-hua Yang, Li Li and Guo-hua Niu

Abstract From low-carbon perspective, this article reviews the determinants of public acceptance for nuclear power technology. Drawing on relevant research results from domestic and foreign scholars, we try to build the explanatory model of public acceptance for nuclear power technology, and explain the process and mechanism of public acceptance through this model.

Keywords Nuclear power technology · Public acceptance · Low-carbon

45.1 Introduction

In recent years, climate change and the task of meeting future energy needs are two intertwined and urgent policy challenges for nations throughout the world, including China (Stern 2007). Reducing the use of fossil fuel and developing low-carbon economy have been seen as two most important ways to reduce the threat of global climate and to achieve sustainable development (IPCC 2007: Moriarty and Honnery 2009). So, the effects of renewable energy in mitigating climate change and reducing GHG has been recognized by public highly (Lloyd and Subbarao 2009). Nuclear power has been reframed as low-carbon technology, on the one hand, it is the possible choice of low emission in the process of using; on the other hand, it is a kind of alternative resource and could solve the problem of energy shortage for many counties, make a country independently in energy

Y. Yang (✉) · L. Li
Shenzhen Graduate School, Harbin Institute of Technology, Shenzhen, People's Republic of China
e-mail: 260782245@qq.com

G. Niu
Education and Personnel Department, Foshan Local Tax Bureau Foshan, Foshan, China

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supply and ensure its energy security. What is more, Chinese government has set an ambitious target to enhance energy productivity by reducing energy intensity by 20 % from 2005 to 2010. In order to achieve this target, non-fossil energy should account for more than 15 % of the total energy consumption, and nuclear power will account for 4 % of it (Gu 2011). At the same time, nuclear power is cheaper than solar, wind and other energy, and could be produced in quantity. Therefore, along with the improved attention of climate change and energy crises, nuclear power technology as low-carbon technology plays an more and more important role in energy policy making, energy supply and economy development.

Although, some scholars explored that the level of public acceptance for nuclear power technology has improved in recent years, many believe public attitude toward nuclear is contradictory. While along with the development of economy, many countries will encounter rebuilding problem of nuclear stations in the nearly few decades, public's acceptance of nuclear power technology becomes more and more complicated after the nuclear accident of Japan on March 11, 2011. From the response of public perspective, this accident increases social fear for people, and produces a huge negative impact on public acceptance; what is more, this accident brings new challenge for the development of nuclear technology, nuclear power companies, the management and control capability of government, and nuclear emergency system (Gu 2011).

So, further research for understanding the situation of public attitude is necessary, because it is not only the premise condition of nuclear power development for nuclear enterprises, but also the base of policy making and implementing for government. This research, from low-carbon perspective, reviews the key factors of public acceptance for nuclear power technology. Drawing on relevant research results from domestic and foreign scholars, we try to build the explanatory model of public acceptance for nuclear power technology, and explain the process and mechanism of public acceptance through this model.

45.2 Previous Studies

45.2.1 Foreign Literature Review

Research related to the public's acceptance of nuclear power technology (stations) has mainly focused on single determinantsof perception and acceptance, such as beliefs and attitudes, affect and worldviews, and knowledge. A few studies examined the acceptance of nuclear power stations only at specific locations. Other studies compared people's acceptance of nuclear power to that of other energy sources.

Recently, some scholars try to explore what decide public acceptance and make them willing to support nuclear stations by action, they believe that the perception of nuclear risks and benefits are the two most important factors. Because nuclear technology risks reduce public's acceptance, and increase the willing of opposition. While, more nuclear technology benefits increase the public's acceptance, and reduce the willing of opposition. In addition, public's trust of nuclear enterprises and government also produce significant influence on public's acceptance. Some scholars also scrutinise environmental damage and perception of costs could affect public's acceptance, although those factors have not been proved directly, just as personal behavior can effect their attitude toward nuclear technology.

45.2.2 Domestic Literature Review

There are not so many literature about nuclear power technology of public acceptance in China, but different scholars have different opinions about the determinants of public acceptance. Xi and Xue studied that when people evaluated the risks of nuclear power technology, they would consider many factors, however, there were four key factors which were familiarity, participating, controlling and trust (Shi et al. 2000). Yu et al. (2009), through a survey of residents who lives near by nuclear station within 30 km, explored that gender, age and education level are the primary factors which affect public acceptance for nuclear power technology largely and deeply. Zhe (2009) analyzed the role of individual factors in public acceptance, and explored perception risks of nuclear power are the primary elements for public acceptance. He suggested that when the government planed to build nuclear stations in the residential area, the main factors are individual expected benefits, the level of trust to public institutions, and the level of understanding of nuclear technology; then, individual benefits are affected by the level of trust to public institutions and understanding of nuclear power technology, the level of understanding of nuclear technology is also affected by the level of trust to public institutions. Zhu et al. (2010) explored the factors affected public acceptance of nuclear power technology are much complicated, generally speaking, nuclear power technology is a kind of special technology, so the access channels of information, trust in government, the level of familiarity with nuclear power, and the level of controlling are the most important factors for public acceptance. Lu et al. (2003) examined that although the safety of nuclear is high, public acceptance of this technology is not increased, it is attributed to the low level of familiarity, controlling with nuclear power, participating and trust. Chen et al. (2009) found that cognitive and emotional factors are the important factors in deciding public acceptance of nuclear power, from the empirical perspective and investigated public acceptance of nuclear power in Shenzhen.

So, it is easy to explored that many domestic scholars have analyzed public acceptance of nuclear power and nuclear power technology from the perspective of multi-factors, but many research are limited on the level of theory, and few empirical research analyze resident acceptance of nuclear power technology by using statistical data and from nuclear power engineering perspective. From the low-carbon perspective and focusing on its role in climate change and energy supply, there is no systematic literature to explain public acceptance through building theoretical model and describe the process of public acceptance. Therefore, from low-carbon perspective, our research draws on the common accepted factors for international scholars–trust, risk perception, benefit perception as the primary factors, and divides benefit perception into climate mitigation benefit and energy supply benefit. Then we build the theoretical model of public acceptance for nuclear power technology ant try to explain the process of public acceptance for nuclear power technology.

45.3 Theoretical Model Building

In the process of theoretical model building, we firstly draw trust, risk perception, benefit perception, then we pay specially attention to the role of nuclear power technology in climate mitigation and energy supply, because the two benefits nuclear brings will be seen as factors which promote public acceptance. Obviously, from the behavioral and cognitive science perspective, perception risks and benefits are the most important and fundamental factors. Our research, based on cognitive theories of new or unknown technology, try to explain the basic structure of public acceptance for nuclear power technology, the following will elaborate the details of the model.

45.3.1 Risk Perception and Benefit Perception

Risk perception and benefit perception seem to be two important factors that predict people's acceptance of a technology such as gene technology, nanotechnology, and also nuclear power stations. In most studies, benefit perception appeared to be a stronger predictor of acceptance than did risk perception, previous studies also confirmed the negative correlation between risk perception and benefit perception, which is anther reason why we want to take the two into consideration. So, the two are included in the building of model. In the measurement of perceived risk, Visschers et al. believe it main includes two aspects, the one is the probability of nuclear accident, the anther is public's total evaluation of nuclear safety.

At the same time, this research attempts to distinguish two types of different perceived benefits for nuclear power technology. As the above-mentioned, the public who support nuclear technology due to the following two reasons: firstly, nuclear power could guarantee the safety of energy supply; second, nuclear power could achieve carbon–neutral and is an effective strategy to mitigate climate change. Although the above opinions are widely accepted, how much perception comes from climate change benefits, how much comes from energy supply security, and to what extent the two kinds of benefits for nuclear technology impacts on public's acceptance and other problems should be solved through further study. From low-carbon perspective, this research subdivides perceived benefits into benefit perception from climate mitigation aspect and energy supply aspect, measures and compares the effect of the two aspects, and learns more about public awareness of low-carbon. Visschers et al. believes that benefit perception from climate mitigation aspect mainly includes the different influence between nuclear power and other energy on climate changing, and to make public to perceive the benefits of nuclear power. He also scrutinised benefit from energy supply aspect means that nuclear technology solves the problem of power shortages, guarantees industrial energy supply security, and impacts the level of public's living standard.

45.3.2 Knowledge

In addition, we believe that when people analyze perception of risk and benefit, they used relevant knowledge, the same is true for nuclear power technology. Knowledge puts impact on public's attitude toward nuclear power and technology. Lay people may gain knowledge and form opinions about scientific research through different types of media. Mass media may not affect people in a strong, direct way, but throughout the long term, it may have an effect on what people think. Knowledge can be one factor influencing the formation of opinions, which can be either positive or negative. Throughout the scientific literature, it is widely assumed that increased knowledge about science or a specific technology will lead to greater acceptance. This assumption suggests that educating the public will increase public acceptance of science and technology. There are studies that indeedly have found a positive relationship between knowledge and the acceptance of science or scientific applications such as gene technology. On the other hand, after the accident of nuclear in Japan, our government makes great effect to improve public's understanding of nuclear power through mass media and other ways, then public's knowledge about nuclear power will improved for the long time, it is necessary to take knowledge as a factor into consideration. What is more, we believe knowledge is the basis of attitude, and it will affect the perceived benefits and perceived risks of people definitely.

45.3.3 Trust

Social trust means people are dependent on others sometimes, and people expect to gain favorable results from others, person is consisted of social relations and social trust. People can not always obtain full of knowledge about the whole risks and make wise decisions every time. Under this situation, people use their social trust to evaluate risk perception. Especially for those who do not have relevant expertise, they often use social trust to analyze risk perception. What is more, when certain technical knowledge is limited, people reply on social trust to analyze risk perception of this kind of technology automatically. Many researchers proved that social trust plays an important role in analyzing risks and benefits of gene technology. Research about public acceptance of gene technology points out that the trust comes from enterprises who operate gene products, technical security management department, scientists and government. Nuclear technology is similar to gene technology, so we believe that social could effect risks and benefits of nuclear technology.

45.3.4 Public Acceptance

Public acceptance means public recognition, the so-called recognition is the process to meet the psychological needs, and makes a particular psychological analysis according to this process and correct decisions. Many scholars believe public acceptance is complex, but no one distinguish it into more than one aspects in domestic literature, they basically analyzed it from one angle, it is not enough from the practice. In the early stage, foreign scholars also studied this problem from one angle, but in recent years, some scholars explored that people show a paradoxical psychology when they try to accept nuclear technology, so some researchers begin to look public acceptance of nuclear technology as a more complex construct and try to explain it from different angles. Bickerstaff firstly proposed the concept of "reluctance" acceptance, in 2002 he studied public attitude toward nuclear power, climate mitigation and radioactive waste nuclear power produced. He combined national census data with local data and made analysis, then he scrutinised that after discussed respondents whether choose nuclear power or climate change, nuclear power is the lesser of two evils choice, or "devil's bargain" benefits. Therefore, he proposed to use a hybrid approach to analyze the public's views on climate change and nuclear power, that is "reluctant" accept which is a complex way to describe the attitude of the participants, he believed the public's reluctance acceptance of nuclear power with the following characteristics: resignation, discomfort, frustration that nuclear energy is not desirable, but in the foreseeable future it may be essential. Bickerstaff et al. suggests that policy emphasized on the effect of climate mitigation will induce people to adopt a reluctance accept position. Since then, Pidgeon et al., Venables

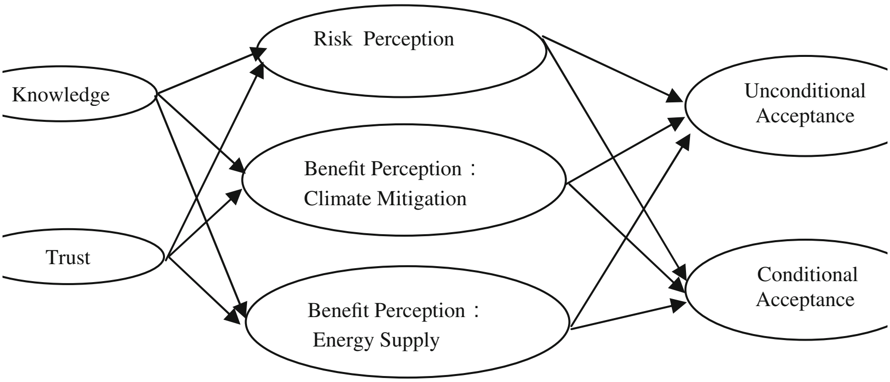

Fig. 45.1 The explanatory model of public acceptance for nuclear power technology

et al., Spence et al., Teravainen et al., Corner et al. and other scholars have confirmed that the people's attitude toward nuclear power is ambivalence, and shown reluctance acceptance features. In the study of the UK's public acceptance of nuclear power, Corner et al. divided public acceptance into unconditional acceptance and conditional acceptance. In his study, unconditional acceptance means people believe the benefits of nuclear power are greater than the harm; conditional acceptance is the concept of Bickerstaff's reluctant acceptance. This research draws Corner's research results and divides public acceptance into unconditional acceptance and conditional acceptance.

Finally, we build the model which contains seven dimensions: knowledge, trust, risk perception, benefit perception from climate mitigation aspect, benefit perception from energy supply aspect, unconditional acceptance and conditional acceptance of nuclear power technology (Fig. 45.1).

45.4 Conclusion

This article is aimed at building a theoretical model to explain people's acceptance of nuclear power technology. In the previous research, several constructs had been suggested and examined regarding what factors influence people's acceptance of complex technologies, but a model based on risk and benefit perceptions and their determinants, knowledge and trust, had not yet been built, although some factors which will impact on public acceptance are not contained. In particular, we explored the concept of "reluctant" acceptance and its relationship between climate change, environmental values and concerns about energy security. What is more important, we describe "reluctant" acceptance with more details, and compare public's unconditional acceptance to conditional acceptance of nuclear power technology. So this research will bring more information for planning and implement of nuclear power technology and stations.

45.5 Limitations and Further Research

However, there are also many limitations in this research. Firstly, the relationship between trust and knowledge has not been discussed clearly, because we do not find specific theory to explain their relationship. Second, we do not identify the relationship between benefit perception from climate mitigation and energy supply, we believe our study perspective is fresh, and no one has explain public acceptance through building model in China as far as know. So in further study, we will make great effect to identify the concept of the two constructs, and evaluate the relationship between the two. Thirdly, there are many other factors which will influence public acceptance of nuclear power technology, but we do not take every factor into consideration, such as affect, individual behavior and so on.

For the above-mentioned limitations, further research is necessary. Firstly, Empirical research is urgently needed. Because through the empirical investigated, we will gain more data, and analysis will show the practice relationship between constructs and the size of affect on public acceptance in every dimensions. Second, in order to collect data, the questionnaire should be developed. If we design the questionnaire of the above model, we think compared research between China and other countries are more interesting and meaningful.

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Chapter 46
Study on the Innovative Characteristics of Systematic Evolution of Creative Industrial District

Yan-fei Xiao, Jia-hua Zhao and Shuang-hong Liao

Abstract In the 21st century, the development of creative industrial district (CID) is paid unprecedented attention by countries and regions in the world. CID is more competitive than general new economic industrial district owing to laying particular stress on the input of culture and creativity. As a special industrial cluster, the innovative characteristics of systematic evolution has not been studied specially, therefore such problems as the dynamic mechanism, the path, the form and the lifecycle of the systematic evolution can not been grasped. This paper constructs the model of dynamic mechanism of the systematic path evolution of CID. Therefore, it promotes form evolution of CID having the characteristics of great self-organization, which leads the initial innovative CID evolving constantly into advanced creative cities. Meanwhile, it promotes systematic cycle evolution of CID having the characteristics of endless innovative lifecycle, which leads low-end art CID evolving into high-end fashion CID. And these characteristics induce more kinds of innovative models and diverse economies, displaying the vitality of a new economic form.

Keywords Creative industrial district · Systematic evolution · Innovation characteristics · Economic form

46.1 Introduction

As a new organization form at the beginning of 21st century, the Creative industrial district (CID) has become the dominant force in regional innovation owing to the characteristics of depending fully on creativity and choosing districts

Y. Xiao (✉) · J. Zhao · S. Liao
Commercial college, Hunan University of Science and Technology, Xiangtan, China
e-mail: xiaoyf2002@yahoo.com.cn

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with the declining space of cultural connotation which brings the transformation of economic growth mode and the updating of function and reshaping of image for city. From the related research, it can be seen the study on CID has become a new focus in industry cluster and regional economies, displaying the research of cluster's dynamic shift in "culture" and "city" (Asheim 2005; Florida 2005; Hall 2000; Landry 2000). CID can be seen as a new economic form is a special kind of industrial cluster, showing in the following aspects: (1) special development space. It mainly chooses declining area of city center (Landry 2000; Hutton 2000, 2004), while normal industrial cluster chooses the area far away from the city center; (2) special development conditions. The soul of CID is the input of culture and creativity, so some scholars make a paradoxical conclusion that not every area can be developed as CID because creative class chooses the location of city (Florida 2002; Scott 2005), but all places can make use of local culture to develop CID, and change the dependence of development paths and realize "new" leap (Bathelt and Boggs 2001; United Nations Conference on Trade and Development 2004). Culture is creativity, therefore developing areas can depend on their own traditional culture to develop CID. However, because of imperfection and immatureness in social economic conditions like creative environment, creative talents, local manufacturing network and so on, the development of some CIDs are destined to be imperfect. Therefore this paper holds that the development of CID forms a global hierarchical system, or it can be said that CID has stages of development such as commencement, growth, maturity and recession; (3) special output. The output of development is mainly cultural consumption of products and services, requiring a certain height level of economic development and the ability in consumption of high value-chained culture. Though many scholars have studied the evolution characteristics of industrial cluster (Mytelka and Farinelli 2000; Ji-ci and Xin 2001), there is still no research on the characteristics of systematic evolution of CID. For the development of industry, systematic evolution research can explore totally such complex system problems as its power of evolution, path of evolution, the form characteristics of evolution stages, tendency of evolution and so on, which are very useful to summarize the developmental law of industry and direct its tendency.

46.2 Dynamic Mechanisms and Paths of Systematic Evolution of CID

Generally, CID has gone through evolution path such as spontaneous agglomeration and external economy, flexible specialization and industrial chain, competition-cooperation effect and differentiation competition, innovation effect and the learning district, reputation effect and regional brand, so it can be explained that agglomeration economy generates flexible specialization production, and all kinds of specialization division impel the formation of Cooperation-Competition mechanism

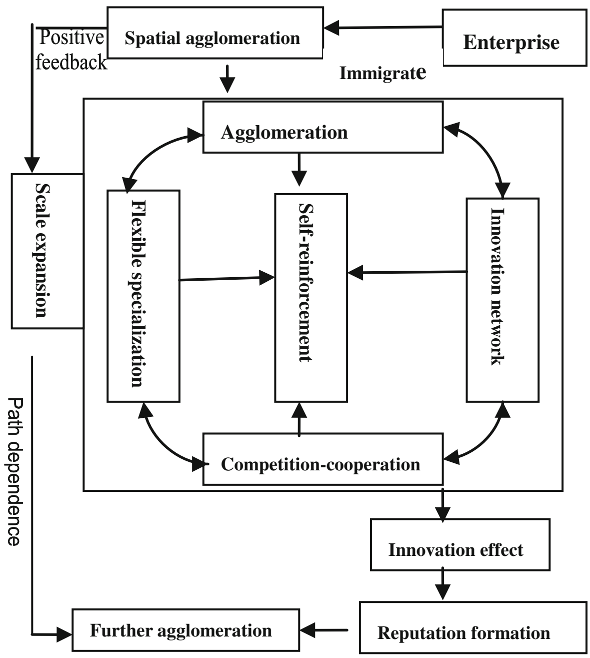

Fig. 46.1 Dynamic mechanism of the systematic path evolution of CID (Guo 2006)

among various kinds of enterprises. Once the cooperation-competition mechanism is formed, the evolution of CID will enter into a benign path of development that is the innovation continually grows, and the results of innovation improves the quality of regional products, thereby forming regional brand and enhancing the reputations continually. In return, it further promotes the agglomeration of CID. As in Fig. 46.1, show the path and dynamic mechanism of systematic form evolution of CID. Just because of constantly positive feedback effect, which makes its further agglomeration, then promotes its generation, development, and maturity.

46.3 Innovative Characteristic of Systematic Form Evolution of CID: Self-Reinforcement

From the analysis of elements of cluster structure, Xia-ming et al. (2004) puts forward clearly about four stages of the evolution of industry cluster that is agglomeration of basic elements, value chain, social network and innovative system. These four stages correspond to the potential, revealed, primary, advanced stage of the development process of cluster. This shows that the systematic form evolution of industry cluster is from the initial concentration to form a network relationship by evolving gradually, and only after this can it innovate. Meanwhile, the evolution of industry cluster's form evolution constitutes its hierarchical system that is the stage of agglomeration can be seen as primary (infantile) stage, then to the intermediate (developmental) stage and at last to the advanced (mature) stage of the formation of innovative system. The budding stage of CID is a simply agglomeration effect, while this time location choices tend to be cheap rents, capacious creative space and inspirational atmosphere. Because of the creative class “liberals”, being a “maverick”, and the “dazzle gens”. In the revealed stage of CID, creative classes don’t have too much contacted, as a result, the agglomeration is also sheer physical agglomeration. However, with the demand of creative products or services rising and the unsocial creative classes, there are various intermediary and supporting organizations appearing in the agglomeration areas, and these organizations become the link between creative classes and markets, so the flexible division of labor occurs. Through the intermediate organizations, creative classes start to communicate with each other and stimulate creative inspiration, thereby forming the good competition-cooperation network. Once the competition-cooperation network formed, CID will enter the benign period of development, attract more creative industry settling, and more people in the business of CID will look for opportunities to develop, so as to promote the innovation continually produce, then forming the innovative network model, which makes creative industry area enter into the mature period and establish reputation. With the growing reputation, innovation will be cycled and self-reinforced constantly, so the CID will enter into a period of great prosperity, and at the atmosphere of originality in the whole society, innovation will produce constantly, then it immediately forms the creative city. For a certain particular creative industry, this kind of systematic form evolution is a developmental stage of evolution that includes agglomeration, elastic production, competition-cooperation, networking, innovation and reputation formation; for all of CID, they can be classified into the initial innovative (beginning and formation), the initial networking (development and maturity), innovative CID (culmination and creative cities), which constitute the hierarchical system of CID with primary, intermediate, and advanced stages. That is to say, the systematic form of the CID develops from primary stage to advanced stage with the stage of evolution penetrating deeply constantly. In addition, this kind of development is not a simple linear rise, but a spiral rise having the nature of systematic evolution, as shown in Fig. 46.2.

46.4 Innovative Characteristic of Systematic Cycle Evolution of CID: Endless Innovation

In the aspect of research on industry district, many scholars apply the theory of lifecycle of the industry to analyze the evolution law of lifecycle of industry cluster. For instance, Jian and Liu (2006) divide into beginning stage, formative stage, mature stage, recessionary stage from the angle of cluster network formation and according to the theory of lifecycle of products, and they also have made sample analysis for silicon-valley.

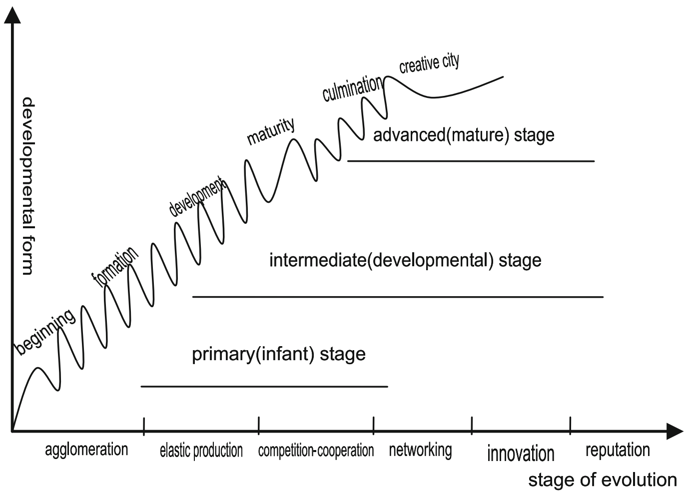

Fig. 46.2 Characteristic of systematic form evolution of CID

Being initiative culture district, the artists and intellectuals play an important role in CID development. In view of types of CID are various which includes the creative art center and software center, and also includes consumption oriented fashion-exhibition and entertainment centre. Therefore, as a kind of high-end industry form which is based on research and development, design and spiritual innovation, its lifecycle is different from general industry. Nowadays most CID is still in the beginning and developmental stage, but it has been developing for 10 years in some developed western countries and forms a particular characteristic in the evolution law of lifecycle by self-evolution. As the New York art center of Caves' space logic research shows that, the spatial distribution of modern art market must have a self-destructive characteristic, and this process in New York has been repeated many times. Since 1982, the east of New York has experienced this cycle for less than 10 years (Caves et al. 2004), but we should see after the art center experiencing stages of recession, property, lack of creativity, high-grade consumption areas, CID with creation is made to evolve to a high-end fashion consumption of creative industry exhibition area. And in the spontaneously CID of market economy, there commonly exists this kind of the evolution law of lifecycle which is "starting with art and ending with commerce". What's more, as the law of lifecycle, CID can experience beginning, formative, developmental, mature, stagnated and recessionary stages, but the difference from general industry is that CID seems to have no recessionary stage in the real sense, and its law and process of evolution of lifecycle can be seen in Fig. 46.3.

When CID from creative center evolves into a high-grade and fashionable business center, its cultural taste and reputation effect before enables the lifecycle of business exhibition center to develop into a new phrase of transformation, thus breaking the evolution law of lifecycle. And from another perspective, it can be

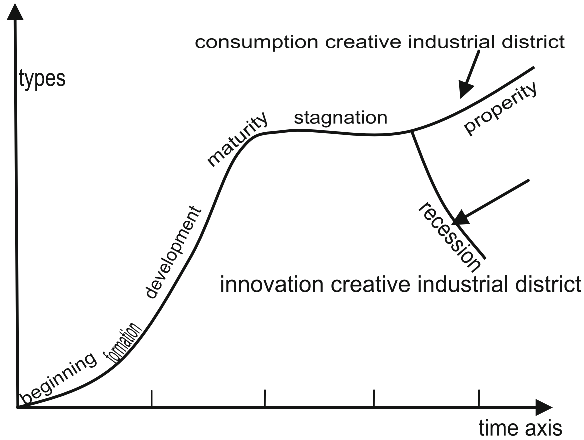

Fig. 46.3 Law of lifecycle evolution of CID

regarded as senior type of CID and the transformation and upgrade of the original state, namely CID of creation transforming into consumption. It should be explained, the "innovative center of consumption" that has experienced transformation is also CID with the creative products and services exhibition, sales, leisure tourism, and other key economic development modes, and has represented a different characteristic comparing to general production industry cluster.

46.5 Conclusion

It is shown in this paper that CID has characteristics of typically complicated system, self-organization and prospectively chaotic evolution. The internal-evolution dynamic mechanisms including agglomeration effect, external economy, flexible specialization and industry chain, competition-cooperation effect, differentiation competition, innovation effect and regional study, reputation effect and regional brand, make the CID appear a upward spiral tendency of self-evolution and self-reinforcement, forming the following aspects: (1)the characteristic of self-reinforced systematic form and the dynamic constantly self-evolved mechanism which have developed from startup type to creative stage, constituted the primary, intermediate, and advanced hierarchical system of CID; (2) CID featured by unlimitedly innovative evolution of the lifecycle and with the corresponding trend, together with the process of lifecycle of art center evolving into high fashion consumption area, brings the rebirth of the function of economy and space and the developmental effect of "leapfrog type", therefore it has the leapfrog unlimited innovation tendency. The analysis of the innovative characteristic of systematic evolution of creative industrial district shows that its development mode is better than general industry cluster, and when tracing the real reason, it can be found that constantly innovative elements created by the input of culture and human brains' creativity, break the normal law of evolution and make the economy develop continually as a result.

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Chapter 47
Coordinated Development of Independent Innovation and Transformation of Economic Mode

Hui He

Abstract Technology innovation is one of the key to change the enterprise economic development mode. The development of new technology depends on the innovation of the materials, the material is the core content of technology progress. This thesis is to expand the case studies for technological innovation to promote economic development pattern of this argument, and put forward some measures to promote the economic development mode shift to technological innovation

Keywords Coordinated development · Innovation · Transformation

47.1 Introduction

The transformation of the mode of economic development in our country faces including system mechanism, policy, culture and science and technology innovation ability and so on various constraints, one of the most fundamental restriction is still insufficient creative ability of science and technology. Only increase science and technology innovation ability, can change the economic development mode change the basis on which the technical route, and promote economic development mode change (Audretsch 2004). At present, China's science and technology innovation ability is not mainly displays in enterprise innovation ability weak, the low level of industrialization of scientific and technological research, science and technology, and the resource distribution imbalance, etc. (Antras 2005). Transformation of the mode of economic development, must have targeted to cope with the challenges, to break the bottleneck restriction creative ability of science and technology. Since the reform and open

H. He (✉)
Electronic Commerce Department of Business School, Jiangxi Normal University, Nanchang, China
e-mail: hehui_1978@163.com

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policy, our country appear some like huawei, zte, haier such innovation ability strong enterprise. But from the whole point of view, our country enterprise technology innovation ability and speed up the development mode change, realize the upgrading of the industrial structure and the requirements of the large gap. In 2008, our country enterprise imported technology digestion and absorption technology import costs and fees than was only 0.24:1. Japan, South Korea imported technology digestion and absorption of the fees as high as the cost of introducing 3–10 times (Fan and Li 2009). Most of the development of the enterprise in China still is not main rely on scientific and technological innovation ability enhancement. If the microscopic economic subject enterprise development mode change, the macro economy development mode, it is hard to change fundamentally. To improve the enterprise technology innovation ability is the relationship between the development of China's industry and science and technology innovation to enhance the ability of the key, is also to speed up the development mode change the urgent requirement (Grossman and Helpman 2005).

47.2 Methodology

Innovation achievement industrialization level is low, also has restricted the innovation efficiency. In recent years, our country come on stage and promulgated by the promotion of scientific and technological achievements reforming process on promoting the transformation of scientific and technological achievements of some provisions and so on a series of laws and regulations, and accelerating the industrialization process of major scientific and technological achievements. In promoting the transformation of scientific and technological achievements policy measures to encourage and support, the transformation of scientific and technological achievements in China ability increased greatly, especially a number of major scientific and technological achievements to the transformation of the productive forces, promote economic and social development to play a great role in promoting (Wang et al. 2004). But the transformation of scientific and technological achievements in China ability still a great room for improvement. The ministry of education a report, the universities in our country has a year of scientific and technological achievements in the 6,000–8,000 between a, realize the achievements and the industrialization is less than 1/10. At present in China have a year of scientific research personnel made scientific and technological achievements of more than 30,000, and has thousands of provincial scientific research item, 20,000 items of patent, the rate of promoting scientific and technological achievements about 15 %, the real application and large get considerable economic benefit is very few. Applied science and technology achievements can't into engineering technology, product and industry, the first productivity role can't play, also cannot support economic development mode change (Rakefield et al. 2004).

And the key technology are underlings, it hinders our country to further improve the industrial chain. After many years development, our country technology dependence although declined, but many key industry core technology of the enslaved situation still do not have a fundamental shift. On the one hand, China's industrial technology in less independent intellectual property rights, and led to many of the key technology industry depends heavily on foreign, become the further development of the industry and to enter the international market of bottleneck (Xiuping 2006). On the other hand, China's production equipment especially technology and equipment level is relatively poor, a large number of technical equipment, especially high-end products mainly rely on imports. Although the equipment manufacturing industry in large scale, but really reflect the profession competitive power of advanced processing technology and important technical equipment is still weak, the market is badly in need of high technology content, high value-added technological equipment and products are a serious shortage (Palvia 2009). If the key technology can't effectively break through, and can't get these key technology from abroad, industrial upgrading and emerging industry development and economic development mode change will be slow.

47.3 Results

Currently, China's science and technology resources layout uneven, and creative ability of science and technology of ascension to give a big challenge. China's scientific and technological resources distribution of different development present situation, the regional technology resources in a wide distribution features in the pattern. From regional R&D funds for a total of the provinces that sort distribution to see, ranking the first and the last province differ 447 times as much, and this difference was enlarged. China's scientific and technological resources configuration pattern and allocation efficiency to difference of different regional innovation ability of the difference, it also determines the different area the connotation of the transformation of the mode of economic development should be different. Conversely, the transformation of the mode of economic development in different areas of science and technology resources optimization allocation and innovation ability the enhancement set the new request (Walczuch and Lundgren 2004).

1. Facilitating independent innovation in system and mechanism innovation to fluctuate

Facilitating independent innovation and economic development mode change must be on the market economic system as the basis, and give full play to the government's guidance and macro-control role, but for the government's behavior must be regulation. Compared with the developed countries, the Chinese government departments have more power obviously, this power if not is properly used, can be obstacles independent innovation and development mode change factors. Therefore, the transformation of the mode of economic development first need to change the government management style. One is the government's power to regulate. The authority of the government should be identified in a rational scope, if the government will dip excessive market territory and cause the distortion of the market mechanism. With the rapid growth of fiscal revenue, the government authority has the expanding trend. This kind of phenomenon must through the form of laws and regulations to curb, otherwise will lead to economic system to the return of the planning system (Salo and Karjaluoto 2007). Two is to highlight the focus of government management. The government's management should be stressed macro management and indirect management, micro management and direct management of the power to intermediary institutions as far as possible. So, can not only help to cultivate a large number of intermediary organizations, establish and perfect intermediary service system, and also help to ease the burden of government work, to focus on development strategy, policy formulation, implementation and check the evaluation, etc. Three is to strengthen the government regulatory function. The government in the system of market economy plays the role of the regulators. When the economic activity of the subject's action against the rules, the government should try to deal with, maintain the order of the market economy. Four is transforming the government performance appraisal method. Performance appraisal way is the government behavior baton, transforming the government performance appraisal is way too much stress on economic growth from the past to change economic growth and economic development mode change pay equal attention to, and the economic development mode change as hard constraint index (Pavlou et al. 2007).

The transformation of scientific and technological achievements are still the science and technology development and economic development of a killer diseases, shall establish and strengthen encourage scientific and technological achievements into real productive forces of the transformation of incentive mechanism. In recent years, our country investment in research on average growth rate of more than 20 %, most of the funds to universities and research institutions. Universities and research institutions in essence is based on knowledge production and talents training for the main aim of the organization, must establish an effective incentive mechanism to encourage its market prospect of scientific research into products and industries. One is the change of pure academic evaluation oriented, engaged in scientific research achievements in scientific research personnel according to scientific research achievements of the economic efficiency and the social efficiency evaluation. Two is to encourage universities and research institutions of scientific research personnel to development of scientific research achievements transformation on its own, in university science and technology park or high-tech zone for innovation. For technical content high, the enterprise cannot undertake the scientific research achievements, the scientific research personnel to conversion and entrepreneurial, universities and research institutions should be given the necessary funding and support facilities. Three is to encourage universities and research institutions of scientific research personnel to scientific research achievements transfer to the enterprise.

Opening-up is one of our basic state policy, must insist for a long time, but our country at present the opening to the level and the level is not high, main performance in the export product competitive ability is not strong, familiar with international negotiations and trade rules of the talents of some important resources there, lack of international pricing, the introduction of foreign high technology is not enough. In the financial crisis and global climate change under the new situation, to rely on independent innovation accelerate transformation of foreign trade growth mode, expand and deepen opening up. Through the importance to introduce technology digestion absorption and to innovation, implementation of the development of science and technology international strategy, optimizing export product structure, and gradually change and promoting our role in international division of labour, and guide the economic development of our country from extensive to intensive way, from the low end to high-end transfer (Egea 2011).

2. Facilitating independent innovation in enterprise innovation and strengthen key industrial innovation

Enterprise is the basic unit of the economic and social activities and micro cells, to become the main body of the independent innovation and transformation of the way that subject (Li and Li 2008). The main body status of enterprises don't reject universities and research institutions' main body status, innovation resources to enterprise accumulation also do not mean put financial research budget is mainly to the enterprise, but that enterprise to universities and research institutions and voluntarily undertake responsibility. More specifically, the enterprise should be the innovation as the basic power (Lee and Choi 2011); The cooperation of enterprises and to the actual demand of market; The government should pay attention to the market demand from the enterprise technology innovation. Although some western countries to our country government procurement policies and independent innovation policy questioned even attack, but the independent innovation is our national strategy, involving state the core benefit, therefore, the independent innovation strategy and policy must unswervingly adhere to.

47.4 Discussion

Improve the industrial innovation ability, in addition to reform the traditional outside key industries, we must make great efforts to cultivate and develop strategic new industry, the upgrading of the industrial structure is to realize the need (Kracher et al. 2005), also is the realization of social and economic sustainable development needs, to promote economic development mode change to have the important meaning. One is to do a strategic new industry development planning. In the objective analysis and accurate grasp the domestic and foreign, and on the basis of clearly China strategic emerging industry development, the general idea of the strategic key and policy guarantee measures, formulate strategic emerging industry development of the regional planning, and guide the development of different regions with regional characteristics of local conditions strategic new industry. 2 it is outstanding strategic focusing on the development of new industries. Want to choose some market demand vast, to economic development, and leading role of structure and economic development mode change effect is obvious, to improve the overall competitiveness of the country and the sustainable development capacity of strategic new industry to key support and promote our country's economic development to the green, low carbon, environmental protection direction transformation. Three depend on independent innovation in cultivating and developing strategic new industry (Gefen et al. 2003). To have basic conditions and technical advantage of some of the strategic new industry of the combination of field with union, strengthen the joint tackling technology, master the development strategy of the commanding heights, and improve the core competitiveness of the industry. Outputs, less emissions, the mode of production and consumption model, promote our country's economy as soon as possible on the endogenous growth track. If the next five years no major breakthrough, the following road go up will be quite difficult. We not only for contemporary people, you are also responsible for future generations to responsible; China as a responsible power, but also for mankind to explore in harmony with nature to contribute to the development model, make contribution to the progress of human civilization.

47.5 Conclusion

Enterprise is the subject of technological innovation. Material is the core content of technology progress. For enterprise that, the key is in the economic development of the development, use, maintains enterprise innovation resources, ensure R&D investment, using a variety of innovation cooperation channels, and improve the enterprises' independent innovation ability, for enterprise development provide strong mental support, to realize the economic development mode change.

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Chapter 48
Exploration and Practice on Innovative Education of Sino-Australian Cooperation

Jian-zhong Lou and Jian-ping Li

Abstract Sino-Australian cooperation is a new model of vocational education. However, there are still some problems such as teachers, teaching materials, resource utilization, as well as English language teaching and the application of advanced teaching methods. These issues have become the bottleneck of the development of Sino-Australian cooperative education. With the carrying out of cooperation projects and the practice of Sino-Australian cooperative education, creative education has became more and more important in the new phase of Sino-Australian cooperation

Keywords Vocational education · Innovation · Sino-Australian cooperation · Distance education

48.1 Introduction

Sino-Australian cooperation has been implemented in our institute for four years. It has undergone a period from exploration to maturity. In this process TAFE was gradually penetrated in the teaching and management mode. Teaching plan which was drawn up by our institute (ZIME) and Boxhill institute in Australia has been executed, Australia's evaluation methods, assessment system and quality standards

J. Lou · J. Li (✉)
Department of Bio-systems Engineering, Zhejiang University,
Hangzhou, China
e-mail: jpli@zju.edu.cn

J. Lou
e-mail: loujz160@sina.com

J. Lou
Department of Mechanical Engineering, Zhejiang Institute of Mechanical
and Electrical Engineering Hangzhou, Hangzhou, China

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were used. Exploration and practice on innovative education of Sino-Australian cooperation determined the survival and development of this model.

48.2 Innovative Education is the Requirements of the New Era

Innovative education is the education that looked the spirit of innovation and creativity as a basic value orientation. Vocational education should develop students with innovation and creation (Jiang 2002). National long-term development plan for education reform has clearly put forward for building an innovative country's needs to strive to improve their creativity ability and good problem-solving ability (Zhang 2005). Without the support of highly skilled personnel and guarantee of high-quality and innovative team, "Made in China" change to "China create" will not be a reality.

It's clear that China need more people with innovative, practical, versatile ability. With the impact of the traditional education, knowledge-based education focused on getting good marks in the test. This model also affected vocational education, thus ignoring the position of vocational education and the development of students. The creative sense of students and entrepreneurial ability has been restricted to some extent. Both self-consciousness and innovative ability of students are weak. They lack of learning ability, practical ability and innovative ability. So strengthen the innovation ability of students and emphasize the adaptable ability in future career is particularly urgent in vocational education.

As an integral part of vocational education, how to develop innovative education in Sino-Australian cooperation at new era has become an important subject.

48.3 The most Important Innovation Leading Force in Education is to Develop Innovative Teachers

Innovative teachers are prerequisite for training creative students. They are also the most important leading force in innovative education (Li 2009; Lou 2011; Wu 2011). Only innovative teachers can undertake the task of innovative education and training of innovative students. Research shows that innovation education and innovative teachers are related closely. If teachers have great creative potential, students may get brilliant future possibly (Sainan 2011; Chen et al. 2011).

The teachers are special because they taught students with double languages in Chinese and English. But lots of them are just graduated from school with master or doctor degree. Although the higher education level, there are still have some problems such as little experience of training in enterprise. The knowledge they teaching come from the books they have ever learned in the past. It is difficult for them to combine the theory with practice, let alone innovative. It is also difficult for students to have the capacity of further studying with the existing knowledge, thus constrained the development of student's thinking (Liu 2010; Wei-hong 2009).

It is the main reason of lacking professional teachers in the Sino-Australian cooperation education that the teacher should not only master the professional knowledge but also familiar with English (Lou and Hongwen 2009). It's also the important obstacle to innovation which further restricts the development of cooperative education with Australia.

For this reason, we should look it as an important and long-term goal to further strengthen the construction of teaching staff, fully attention to importance of professional teachers in the professional construction and innovative education.

48.3.1 Training in Australia

The teachers who training in Australia will not only study and understand the advanced experience and methods in Australian education, but also practice with a given task and application when they come back, played a leading role in this model of cooperation education.

48.3.2 Australia Teachers Involved in Teaching in China

Australia teachers will increase the vitality in Sino-Australian cooperation education. Their advanced teaching methods and ideas will inject vigor and energy, combined with the professional teachers in our school which will greatly strengthen communication of teachers between China and Australia.

48.3.3 Teachers Deeply Participate in the Research of Enterprise

Teachers in Sino-Australian cooperation should deeply participate in the research of enterprise. They will have both the high quality of teaching theory and practice ability to adapt to the development of vocational education in the future.

48.3.4 Multimedia Used in Classroom

Blackboard and chalk is the traditional teaching methods teacher used in the old times, but this approach has not suited to modern times. With the development of electronic technology and computer network, multimedia has been applied to classroom, the changes in the way of education interested the students, while improved teaching efficiency.

48.3.5 Distance-Education

The use of online education in domestic is general, but it's is a new phenomenon in international cooperation education. It broken the national boundaries, and shorten the distance. At the same time solve the problem of high cost shortage of teachers in international cooperation education.

48.4 To Strengthen School-Enterprise Cooperation

School-enterprise cooperation is the important practical measures to seek self-development of institute and gradually connect with the market, improve the quality of education and purposeful train for skilled and technical students. It reflects the most distinctive and closest characteristics of vocational education, society and enterprise, and it is the key to the current education mode of vocational education reform and innovation including teaching, training mode, evaluation mode. It also looked as an important way to takes into account vocational education as economic and social development and industrial development planning, promote vocational education scale, professional settings, and needs of economic and social development. This model is worthy of being referred in Sino-Australian cooperation.

It is necessary to contact with local enterprise and industry and focus on strengthening the base construction of practical training. Then to establish stable training base of Sino-Australian cooperation and combination the teaching, production, management and service with each other. Actively explore the mechanism of training bases construction and approaches to creative education.

School has gradually accumulated a good reputation in the community and the establishment of a wide range of social relations in the development process, which has made a good external guarantee in the implementation of cooperative education. How to make full use of existing resources, organic combination the classroom education and on-site education which can directly access to the actual capacity and production experience. So that students can gain practical experience in social practice. In the process of practice training, fully management was established smoothly and efficiently, as shown in Fig. 48.1.

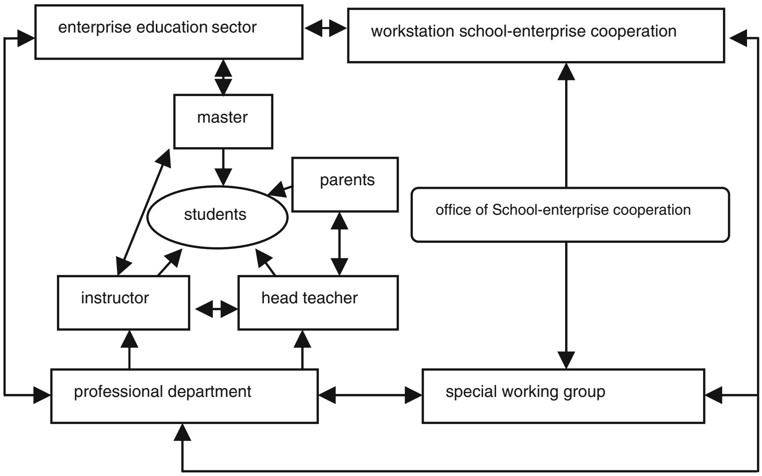

Fig. 48.1 Diagram of the process control system

In the process control system, "the four evaluations" is the core of the evaluation system that means the master evaluation, enterprise management evaluation, instructor evaluation, student self-evaluation to determine final result of students training.

48.5 Play Advantages of Sino-Australian Cooperation—Strengthen Foreign Language Teaching

For students in Sino-Australian cooperation classes, on one hand he or she should have perfect English. On the other hand they should have a solid foundation of professional knowledge, so the training objectives should be built from the knowledge, ability and so on.

48.5.1 Emphasizing the Cultivation of English Language Ability

Communication skill is the most important one in English learning. But the English learning habit should be change from passive learning to active learning.

English language environment plays a decisive role in learning English for students. How to create effective English language learning environment is what we should consider. Teachers should bold to probe in the English curriculum reform and innovation in an atmosphere of respect mutually, using of new teaching methods.

48.5.2 Establishment of a Competency Assessment System

"Test is the evaluation", this view is still deeply rooted in Chinese students. The current evaluation system focus on distinguish, selection and other functions, ignores the improvement, motivation, development and results was considered rather than process, too much emphasis on similarities and general trends, ignoring the differences between individual students. The practical ability, study habits, psychological quality, innovative, comprehensive quality assessment was neglected or the lack of effective evaluation tools and methods. It is important to establish a competency-based assessment system. Combine routine testing, skills assessment with each other and emphasis on assessing students the ability of using knowledge to solve practical problems.

48.5.3 The Integration of English and Professional

English education cannot be divorced from professional knowledge. Knowledge integration is the goal of knowledge construction. Students in Sino-Australian cooperation general pay more attention to English learning, but lack in professional knowledge, so it is necessary to strengthen the learning of professional knowledge and furthermore to apply their knowledge to enable students to improve English learning initiative, to expand, optimize and update their knowledge.

48.5.4 Material Reflect the Characteristics of the Current Times

Materials is an important and indispensable condition of teaching, materials used in Sino-Australian cooperation generally use original materials from Australian. For example, there is no suitable material about the course of "Manufacturing Engineering", and the material from Australian "MANUFACTURING ENGINEERING AND TECHNOLOGY" have 1,324 pages which related to materials technology, a variety of cold and hot processing, advanced manufacturing technology and other aspects, but the original material is too detailed and too much emphasis on theoretical ability, so it is not suitable for direct used as teaching materials for college students especially for the students in vocational education.

The students in vocational education are different from the students in higher education. It also requires the selection of materials in which theory is connected closely with practice. So teachers should actively involved in preparing their teaching materials and integration of practical application in the teaching materials to strengthen the contents and knowledge in order to reduce the theoretical derivation, and fully reflecting the latest developments and trends at the same time.

48.5.5 Play the Role of Network

Popularity of the network makes the information transfer very quickly, which will help English learning. Reasonable use of the network can expand information, increasing knowledge at the same time, and can quickly improve their English listening and speaking.

48.6 Conclusion

Innovation is a continuous practice of teaching and long-term accumulation of experience, especially in mode of the Sino-Australian cooperation. There is no existing experience for reference. It relates the survival and development of this model. At the same time, the Sino-Australian cooperative education is facing a growing pressure of employment. It should continue explore cooperation in professional construction and embark on a road with its own characteristics.

Use of the network and multimedia and develop the distance-education. Resolve the existing problems of hardware and software in Sino-Australian cooperation as soon as possible.

Form a student-centered teaching philosophy gradually.

Continue to strengthen English learning and stimulate interest and enthusiasm of English learning at the same time.

Strengthen construction of teaching resources, strengthen school-enterprise cooperation, and further optimize the structure of courses and the teaching resources.

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Chapter 49
Path Choice of Constructing a Scientific and Technological Innovation System in Universities

Jin-ping Wang and Lian-sheng Yang

Abstract The university innovation is indispensable in the process of building an innovative country. Indeed, a university is an important carrier of a scientific and technological innovation system. In the new century and new stage, a scientific and technological innovation system is demanded in the internal and external environments faced by universities and the objective conditions of China's economic and social development. The paper analyzes the bottleneck in constructing a scientific and technological innovation system in universities and points out the path choice of constructing a scientific and technological innovation system in universities.

Keywords Scientific and technological innovation system · Scientific and technological achievements · Talents

49.1 Introduction

Nowadays, technological revolution is conducted rapidly and knowledge economy is in full swing. Any country that wants to be self-reliant and strong can not succeed without innovation, especially scientific and technological innovation. Universities have an irreplaceable role during this process, because they are not only the birthplace of talents but also an important force in scientific and technological innovation. In this sense, "A university, as one of the most important parts of national scientific and technological innovation system, is a knowledge

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J. Wang (✉) · L. Yang
Faculty of Humanities and Social Science, Dalian University of Technology, Dalian, China
e-mail: wjpliu@163.com

J. Wang
Dalian Nationalities University, Dalian, China

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innovation and dissemination base where basic research is conducted and high-technology is explored. National innovation system is a network composed of national research institutes, universities, enterprises and nongovernmental R&D (research and development) institutions and other establishments. Those establishments, distinct in features and complementary in functions, collaborate together so that the country can enhance more effectively its innovation capability and innovation efficiency, making science, technology and social economy integrated and develop together (Zhou and Yang 2005)". Conceptually, the so-called scientific and technological innovation system refers to that "Universities readjust, assemble a variety of resources (both tangible and intangible) and optimize their allocations, so as to create an organic and complete guarantee system which is in favor of the development of science and technology in universities (Wu 2005)". Huang Boyun, the academician, said, "The most active areas of scientific and technological innovation in the world today all have first-class universities (Luo 2002)". In the process of creating a national innovation base and platform, we should give full play to the role of universities.

49.2 The Necessity of Constructing a Scientific and Technological Innovation System in Universities

49.2.1 The Survival and Development of a University Demands a Scientific and Technological Innovation System

Scientific and technological innovation must be generated in a specific environment, and ask for adequate resources as an impetus to constantly improve and update itself, and maintain a continuous ability of innovation. Without resources, scientific and technological innovation will be like a river without sources or a tree without roots. In this new century and new stage, the competition among universities is increasingly fierce; the trend of international competition and internal competition brings challenges to the survival of all universities. Competing for talents and students has become a normal model. In China, competition is happening all the time among universities of Project 985, universities of Project 211, common universities and higher vocational and specialized colleges. The core of this process can be concluded, "Research competition, talent competition and resource competition". There is no doubt that research, talents, resources and many other factors are all related with scientific and technological innovation system. It is no exaggeration that there will be no research, talents and resources without scientific and technological innovation system. In this sense, "The scientific and technological innovation system is the basic element to cultivate academic masters and excellent faculty teams, a carrier of intersection, infiltration and development among different disciplines, a platform for knowledge innovation, technology innovation and high-tech fruit display, and a premise to improve teaching and talents cultivation (Dai and Yangmin 2003)".

49.2.2 "New Economy" Era Demands a Scientific and Technological Innovation System in Universities

The typical characteristics of "New Economy" era are its comprehensive construction with "technology" as its core. Technology plays a major role, which also directly proves the thesis "Science and technology are the primary productive forces". At present, "New Economy", with information technology, aerospace technology and microbial technology as its core, is taking shape. Scientific and technological innovation plays an important role in promoting economic and social development, and improving the productive methods and lifestyles of human beings. Further study will find that universities, as a significant platform for providing "the source of scientific and technological innovation", take on the duty of providing "core" for the three technologies, which may not play a decisive role in the economic and social development, but it is definitely an important role. Only innovation of original research can provide security and support for all the innovations in the production process. Otherwise, it is impossible to boost the development of economy and society.

49.2.3 Constructing an "Innovative Country" Demands a Scientific and Technological Innovation System in Universities

"To build an innovative country, we need to foster tens of millions of specialized talents and a large number of top-notch innovative talents, and provide a steady stream of talents for this undertaking. Universities should be responsible for cultivating these talents (Huang and Xie 2006)". "Great education" is the prerequisite and basis of innovation (including science and technology innovation). Innovation is impossible without education. There is no doubt that colleges and universities are not only the intellectual source of scientific and technological innovation, but also an important force in the construction of a scientific and technological innovation system. Logically, a university is one of the main fronts of the scientific research which is the forerunner of scientific and technological innovation. Therefore, a university is one of the most "appropriate" forces for technological innovation. This virtue has been well verified in many developing countries, including China.

"National scientific work in 2003 achieved fruitful results: all the universities published 778 technology monographs and 387,290 papers, obtained 3,954 patents, and signed 7,809 technological transfer contracts. The total amount is 2.37 billion yuan and the actual income 1.1 billion yuan. In 2003, inland universities won 115 prizes of the three major kinds of national S&T prizes: 13 awards of National Prize for Natural Sciences, accounting for 68.42 %; 11 awards of National Invention Prize, accounting for 57.89 %; 91 awards of National Prize for Progress in Science and Technology, accounting for 59.1 %. According to the prizes announced this year, the ratio is still rising, which reveals the ability of universities' innovation (Xie 2005)".

49.3 The Bottleneck in Constructing a Scientific and Technological Innovation System in Universities

49.3.1 Lack of Talents, Especially Senior Faculty Talents, Limits the Construction of the Scientific and Technological Innovation System in Universities

A university is a place to cultivate and foster talents, but the prerequisite is to have competent teachers. Excellent teachers are precious resources for the development of universities and the key to the quality of higher education. It can be said that good teachers are indispensable in constructing a scientific and technological innovation system. There are no weak soldiers under a capable general. A strong military force must have good commanders to lead and guide them. Otherwise, this "military force" will not be powerful. As for the teachers in China's higher education, there is an obvious difference among universities, regions and majors. In addition, judged from the ratio of labors in R&D activities to labor forces, the ration of researchers and labors in R&D activities per 10,000 forces are quite low, though China has certain advantages on gross. The ratio is 22 and 18 respectively. Finland has the top ration: 209 and 145 respectively (see Table 49.1). After analyzing the reality, it is easy to find that China's overall R&D situation presents a series of characteristics, such as imbalance in regional distribution, between urban and rural areas as well as between the east and the west.

49.3.2 The Difficulty in Commercializing Research Findings Limits the Construction of the Scientific and Technological Innovation System in Universities.

Although scientific and technological innovation system is an important platform to generate scientific and technological achievements, most achievements can not be

Table 49.1 The ratio of labors in R&D activities to labor forces

Country	Years	Labors in R&D activities (man year)	Researchers	Labors in R&D activities per 10,000 labor forces (man year)	Researchers per 10,000 labor forces
China	2007	1,736,200	1,423,400	22	18
Finland	2007	56,243	39,000	209	145
France	2006	363,867	211,129	132	77
Germany	2007	498,000	286,000	120	69
Japan	2006	935,182	709,691	141	107
America	2005		1,387,882	0	93
Russia	2007	912,291	469,076	122	62
Singapore	2006	30,129	25,033	117	97
South Africa	2005	28,798	17,303	17	10

From OECD Main Science and Technology Indicators 2008/2; homepage of Ministry of Science and Technology; http://www.sts.org.cn/zlhb/2009/hb2.1.htm#2

turned into practical technologies in time. Judged from the current situation, whether scientific and technological achievements can be commercialized effectively has become a core part of this system. The logic of "results-commercialization-new results" is an important step to promote scientific and technological innovation system. Results come out first. Then these scientific and technological achievements are commercialized effectively to ensure the enthusiasm and motivation of those who further the study, which is the key to generate higher-quality achievements. If science and technology achievements can not be commercialized into actual productivity, those achievements can only be called "fruitless flowers, beautiful but useless". While the ultimate goal of scientific research in universities is to help convert those scientific research achievements obtained into technologies in favor of people's livelihood. Otherwise, a scientific research will lose its original meaning. At present, the rate of commercializing scientific and technological achievements in China is less than 20 %, and only about 5 % achievements have been developed into industries, which is far below the level of 70–80 % in developed countries, even lower than India's 50 % (Li Zhangcong 2008). So we have to say that the situation is not optimistic. "According to statistics, there are about 10,000 scientific and technological achievements are certified China's universities each year, of which about 30 % have good promotional values and industrial prospects, but only 10–15 % of scientific and technological achievements through the identification of about 30 % of the project has good promotional values and industrial prospects, but only the rate of commercializing these achievements is only 10–15 %. A large number of scientific and technological achievements possessing industrial prospect is laid aside, showing a situation 'large results, small conversion, difficult promotion'".

49.3.3 Stubborn Policies and Poor Operation Limits the Construction of the Scientific and Technological Innovation System in Universities

Policies on science and technology are shelters for ensuring a smooth development of science and technology. On the level of policies design, the amount of macro policies is relatively abundant, while those detailed and precise policies are relatively inadequate. The problem that policies on science and technology in universities are not adequate mainly reflected in the following aspects: first, the setup of institutions has no agreed standards. In the preliminary stage, ambiguous policies are designed; when implemented, those institutions have no examples to follow, leading to a casual operation and implementation. Some policies even have exceeded what is proper. As for the setup of those specific sectors protecting scientific researches, the department of science and technology in a university often lack a relatively complete and standard design system, similar to the design of many other universities. The phenomenon of imitating even copying each other's rules and norms is more serious. Many policies are not tailored to their actual situation, but "To learn from each other and refer to each other". Second, the coordination mechanism of research institutions in higher education has not been effectively set up. The research institutions have not given full play to the role of coordination. They still are simply assuming the role of "Message transmitter" in the era of planned economy, instead of becoming a platform for effective publication and promotion. Therefore, some excellent research results can not be effectively output. They have not given full play to the role of coordination and even become institutional barriers to promote and publicize scientific and technological achievements.

49.4 Path Choice of Constructing a Scientific and Technological Innovation System in Universities

49.4.1 Attach Great Importance to Teacher Teams: Excellent Teachers Prior to Outstanding Students

It is the principal responsibility for universities to foster talents and conduct scientific researches. So this has put forward higher requirements for university teachers. It can be said that there will be no good soldiers without a capable general. In recent years, with the popularization of higher education and a rise in the gross number of undergraduates and postgraduates, teachers of higher education, especially high-education teachers, are badly needed. It's getting harder and harder to find a "good general". As for the number of the researchers in higher education, "The researchers in R & D activities of higher education in 2007 are

254,000, with an increase of 4.7 % compared with 2006. Among them, scientific research (basic research and applied research) personnel are 214,000, an increase of 5.4 % compared with 2006". "In the list of the three major kinds of national S&T prizes (National Prize for Natural Sciences, National Invention Prize, National Prize for Progress in Science and Technology) announced in 2006, higher education accounted for 50 %. Among them, universities won 75 awards of National Prize for Natural Sciences in the Tenth Five-Year Plan, accounting for 55.07 % of the total number; 64 awards of National Invention Prize, accounting for 64.4 % of the total number; 433 awards of National Prize for Progress in Science and Technology, accounting for 53.57 % of the total number. Besides, 61.7 % State Key Laboratories are in universities; 38.7 % members of Chinese Academy of Sciences and Chinese Academy of Engineering are working in universities; among the members Chinese Academy of Sciences newly elected days ago, 55 % are from universities".

49.4.2 Vigorously Promote the Commercialization of the Scientific and Technological Achievements in Universities, and Open up a Broader Space for Their Scientific and Technological Innovation

The efficiency and quality of universities in commercializing their scientific and technological achievements will provide a practical guarantee for the construction of scientific and technological innovation system. Comparatively speaking, the higher the commercialization rate of scientific and technological achievements is, the better the quality is, the more we can promote the improvement and development of scientific and technological innovation system, otherwise, it will hinder its improvement and development. Because of it, we can promote the commercialization of universities' scientific and technological achievements from the following aspects: First, we should bring the synergistic effect into play and focus on the dynamic integration of Industry-University-Research in the process of constructing a scientific and technological innovation system. The dynamic integration of Industry-University-Research is to examine the scientific and technological achievements in the Industry-University-Research system. Universities and researches should aim to serve and support industries. The three interact as both cause and effect, help each other forward and promote common development. The second is to focus on the cultivating and developing technology parks in universities, making the hatchers of scientific and technological achievements. "Technology Park in universities is an incubation base for scientific and technological achievements, based on their scientific and technological resources, information resources, technology professionals and university intangible assets, relying on the comprehensive advantages of the discipline groups and being market-oriented. Its central task is to develop high-technology and promote industrialization (Hao 2004)".

49.4.3 Improve our Policy Protective Mechanism to Give Universities Rules to Follow in Constructing Scientific and Technological Innovation System

Guarantee policies for scientific and technological innovation system should focus on the government guarantee policies and universities guarantee policies.

1. The government provides guarantee policies. In China, a vast majority of universities are public ones, which directly determines the government's irreplaceable role in the process of school-running. The government should pay more attention to the following aspects in ensuring a scientific and technological innovation system. First, strengthen government's financial support. Money is not everything but we can do nothing without money. This sermon is also applicable to universities. The government should strengthen its investment for science and technology innovation in a constant manner. Second, act as a go-between for universities and companies. The cooperation between universities and companies can be flexible and follow no set form. In this regard, universities should not only cooperate with the enterprises in its region, but also have the courage and vision to work with outland enterprises, wherein a lot of work must be undertaken by the government. Third, provide preferential policies to encourage universities to establish technology parks. Technology Park is an important part in constructing China's scientific and technological innovation system in recent years, but it must be noted that the Technology Park should not be an occasional project. It must have a solid project as its carrier and avoid being flashy.
2. Universities provide guarantee policies. The construction of scientific and technologic innovation system in universities can not do without the blessing of a good policy environment. Universities should pay more attention to the following aspects in ensuring a scientific and technological innovation system: The first is to create a good environment for talents to live and work. Universities should improve their humanistic concern about the talents and retain them through emotional touch and attractive positions, so as to maximize their subjective initiatives to provide a steady flow of intellectual support for scientific and technological innovation. The second is to create policy conditions, encouraging talents to "go out". Scientific and technological innovation is not possible if the work is conducted by divorcing from the reality. We must open our eyes to see the world, stand in reality and learn from virtuous persons. This requires us to visit virtuous persons and know their practice so as to absorb them for our own use. The third is to emphasize performance assessment and perfect the assessment system of scientific and technological innovation. The assessment is the key to judge the quality of scientific and technological innovation and directly influences the ideas and values that scientific and technologic innovation system should be adhering to. Current assessment mechanisms emphasize too much the number and level of papers whose practical utility is

ignored. It can be said that the some assessments on scientific and technological innovation are too short-sighted. Just focusing on what's right under their nose instead of the long-term issues are also pressing issues faced by the scientific and technological innovation in universities. In this regard, we should give the construction of assessment mechanisms due emphasis.

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Chapter 50
Large-Scale Collaboration Network Structure and Firm Innovation: An Empirical Research

Yan Zhao and Xiang-jie Zheng

Abstract Researchers have argued that alliance network structure can influence firm innovation. We construct alliance networks of 10 high-technology industries in China to analyze their structure characteristics. We use negative binomial regression to study the impact of alliance network structure on the innovation capability of firms. The empirical results show that firms embedded in alliance networks with higher reach will have greater innovative output, and the impact of clustering on the innovation capability of firms is not significant, but the alliance networks that exhibit both high reach and high clustering will obviously improve the innovation capability of firms. These conclusions will provide new scientific basis for firms to develop alliance activities and for relevant government departments to make industrial policies.

Keywords Alliance firms · Network structure · Innovation capability · Patent

50.1 Introduction

Innovation can promote economic development and improve production efficiency, so it arouses widespread concern in academia. Network researchers have argued that cooperation among actors affect their behaviors and creative output. Chen and Guan (2009) constructed patent collaborate networks for 9 innovative countries, and their empirical results showed that both short path length and higher small world quotient are correlated with increased innovation. Uzzi and Spiro (2005) analyzed collaborate networks of the creative artists who made Broadway Musicals from 1945 to 1989, and argued that the large-scale structure of the artists'

Y. Zhao (✉) · X. Zheng
School of Management, Shanghai University, Shanghai, China
e-mail: xiangjie5065@163.com

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collaboration network significantly influenced their creativity. Guimera et al. (2005) constructed scientific research collaborate networks for 4 subjects (ecology, astronomy, economics and social psychology), and found that dense network promoted outputs of scientific research.

Strategic alliances help firms to absorb external resources and knowledge, optimize the allocation of resources, and improve the competitiveness of enterprises. Therefore, collaborative networks among firms also have potential impact on innovation. Soda (2011) examined alliance networks structures of global auto industry, and reported that network position significantly influenced firm's innovation performance. Schilling and Phelps (2007) analyzed the alliance networks of 11 American high-technology industries, and proposed that interfirm collaboration networks also influence firm innovation. These raise the following questions: Does the large-scale interfirm collaboration network in China influence innovation capability of firms in the network? If so, what structural properties will enhance firm's knowledge creation?

To address these questions, we focus our study on two important structure indexes: clustering coefficient and reach, and analyze their impact on firm innovation. Dense local clustering can promote mutual trust among nodes, accelerate the flow of information, and improve knowledge transmission capacity. In addition, higher reach can ensure that all kinds of non redundant information resources can be absorbed by firms in the network (Burt 2001). Therefore, we argue that the alliance networks that exhibit both high reach and high clustering will obviously improve the innovation capability of firms.

We organize this paper as follows. First, the main ideas of alliance network structure and firm innovation are presented, thereafter we provide the hypothesis. Then our research methodology is presented. Finally, we discuss our results and give conclusions.

50.2 Network Structure and Innovation

When firms form and maintain alliances with each other, they are weaving relationship networks. Firms embedded in these networks can gain access to knowledge and technologies from their partners, and increase the creative output (Gomes-Casseres et al. 2006; Owen-Smith and Powell 2004). So we argue that alliance network structure influence firm's innovation capability and clustering and reach play important roles in firm's knowledge creation.

In interfirm knowledge networks, knowledge and information will be exchanged more intensely or frequently when they have similarities or complementarities. Technology similarity or geography proximity will lead to a high degree of clustering (Baum et al. 2003), and this will enhance transmission capability of knowledge information. On the one hand, clustering can accelerate the flow of knowledge and information, deepen collective understanding, and ensure the accuracy of knowledge and information; on the other hand, firms that are embedded in networks are able to obtain richer and more complete information. Each firm has its distinct knowledge and advantages. Therefore, exchanging heterogeneous information among firms is an effective way to recombine their knowledge and advantages.

Network size and average path length also have important influences on information diffusion and recombination. If a firm can reach more firms, it can gain much more knowledge and information from other firms. Probability, speed and completeness of knowledge transfer are related to path length directly, the shorter average path length, the more quickly and more complete information transfer (Watts 1999). Therefore, firms that are embedded in alliance networks with more nodes and have shorter average path length are able to gain more information quickly, and have less information distortion risk.

Hence, our hypothesis is:

Firms that are embedded in alliance networks with higher reach and higher clustering will exhibit higher innovation capability than firms in networks that do not have these characteristics.

50.3 Models

To test our hypothesis, based on three-year windows (i.e., 2000–2002, 2001–2003 …, 2006–2008), we use the alliance relationship data from SDC Platinum database to construct an unbalanced panel of Chinese firms in 10 high-technology industries for the period 2000–2008, resulting in 7 snapshots of network structure in each industry, for a total of 70 alliance network snapshots. Each network snapshot is constructed as an undirected binary adjacency matrix, and network structure indicators can be calculated by the programming or statistical software. Component structure for 2000–2002 is depicted in Fig. 50.1. A summary of network size and structural statistics for each industry (2000–2008) is presented in Table 50.1.

50.3.1 Dependent Variable: Patents

Patent is an effective and steady index to measure firm's knowledge creation (Trajtenberg 1987). Firms in high-technology industries often use patent to manifest their knowledge creation achievement, so $patents_{i\ t}$, the number of patent applications and successfully approved for firm *i* in year *t*, represents their innovation capability. Patent data are totally extracted from CNIPR, and are checked by CD-ROM patent database for their accuracy.

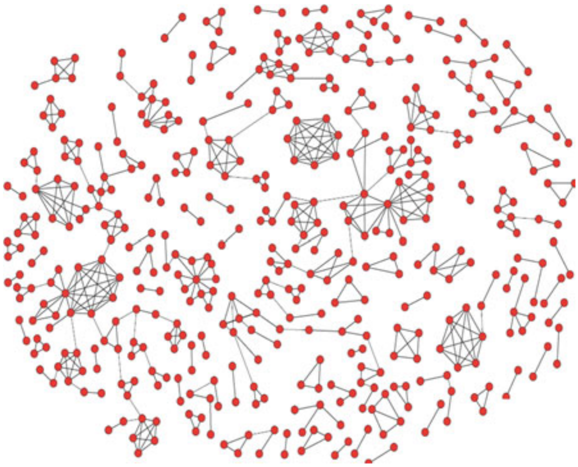

Fig. 50.1 Network in year 2000–2002

Table 50.1 Alliance network size and structure statistics for each industry (2000–2008)

Industry	Number of firms	Average network size (average number of nodes in each snapshot)	Average percent in main component (%)
Semiconductors	130	42.4	18.5
Measuring and controlling	15	5.2	100
Aerospace	22	8	70
Chemicals	210	71.2	10.7
Computers	97	33.7	27.3
Household audiovisual equipment	43	15	80
Automotive	195	71.3	26.1
Petroleum refining	55	17.5	75
Telecommunication equipment	145	45.9	43.2
Pharmaceuticals	150	49.6	25.2
Average number	106.3	36	47.6

50.3.2 Independent Variables

1. *Clustering coefficient*: Clustering coefficient measures the percentage of a firm's alliance partners that are also partnered with each other. This variable can be calculated as

$$clustering_{\omega} = 3 \times N_{\Delta}(i)/N_3(i) \tag{50.1}$$

Where N_{Δ} (i) is the number of triangles in the graph, and a triangle is a set of three nodes, each of which is connected to both of the others. N_3 (i) is the number of connected triples, and a connected triple is a set of three nodes in which at least one is connected to both the others. The factor of three in the numerator ensures that the measure can range from 0 to 1, with larger values indicating higher clustering.

2. *Reach*: We take into account both the number of firms and path length to calculate reach (Borgatti et al. 2002). This measure is calculated as

$$reach = \left[\sum_{i=1}^{n} \sum_{j=1}^{m} \frac{1}{d_{ij}} \right] \Big/ n \tag{50.2}$$

where n is the number of firms that can be reached by any path from a given firm, and d_{ij} is the path length (minimum distance or geodesic) it takes to reach them. This variable can range from 0 to n, with larger values indicating higher connectedness.

3. *Clustering*reach*: The interaction term, clustering*reach will be measured to predict the impact of the combination of clustering and reach on member firm innovation.

50.3.3 Control Variables

1. *Presample*5, the sum of patents obtained by a firm in the 5 years prior to its entry into the sample, are used to control for unobserved heterogeneity in firm patenting.
2. *Partner presample*5, the sum of patents obtained by all direct alliance partners in the 5 years prior to its entry into the sample, are used to represent alliance partners' knowledge stock.
3. *Betweenness centrality* (*BC*), the centrality of a focal firm in a network, is calculated as the fraction of the shortest paths among other firms that pass through the focal firm, and it indicates the firms' control power in the network. We employ Freeman's (1979) measure of betweenness centrality to operationalize Centrality.
4. *Network density*, the ratio of existing links in the network to the number of possible pairwise combinations of firms, and we can calculate it as

$$density = l/[n(n-1)/2] \tag{50.3}$$

where l is the number of existing links, n is the number of the nodes. This variable can range from 0 to 1, with larger values indicating increasing density.

50.3.4 Model Specification

Patents, the dependent variable in this study, is a count variable and takes on only nonnegative integer, so we use negative binomial regression to construct the models (i.e., sample is negative binomial distribution.). It often takes firms 1 or 2 years to realize the innovation benefits of interfirm alliances. Thus we consider the lagged effect, and employ 1-year and 2-year lags to ensure the robustness of our findings.

50.4 Results and Discussion

We use panel negative binomial regression models with random effects to estimate after Hausman test. Table 50.2 describes the results of the negative binomial regression model. Models(1, 2, 3), models(4, 5, 6)and models(7, 8, 9) respectively report the regression results using 0-year lag, 1-year lag and 2-year lag between the independent variables and firm patenting.

It is known that higher clustering enhances mutual understanding and mutual trust between each other, makes information exchange smoother, and ensures information more accurate. However, the impact of clustering on the innovation capability of firms doesn't exhibit statistical significance. One explanation for this is that when clustering is close to a certain high level, firms may gain more redundant information and repeated knowledge, and therefore higher clustering is unable to improve the innovation capability of firms.

Reach has significantly positive influences upon patents$_{i\ t\ +\ 0}$ and patents$_{i\ t\ +\ 1}$, which demonstrates that firms embedded in alliance networks with higher reach will have greater innovative output. Because higher reach endows firms with convenient access to other firms, and obtain more abundant knowledge information to recombine. However, significant impact disappears in 2-year lag. One explanation for this is that the benefit of firms from marginal increment of useful information decreases over time, so it is unable to greatly enhance firm's innovation capability.

Clustering*reach has significantly positive impacts on patent output (patents$_{i\ t\ +\ 0}$, patents$_{i\ t\ +\ 1}$, patents$_{i\ t\ +\ 2}$), thus our hypothesis is supported. Firms embedded in alliance networks that exhibit both high reach and high clustering can exchange knowledge information more expediently, more quickly, and more efficiently, so they can prompt knowledge creation.

Based on the data of 10 high-technology industries in China, we explore the impact of alliance network structure on the innovation capability of firms. The impact of clustering on the innovation capability of firms is not significant, but firms embedded in alliance networks with higher reach will have greater innovative output. Therefore, network structure attribute should be considered adequately when firms develop alliance activities and when relevant government departments make industrial policies. Excessive scattered alliance networks will cause information exchange inconvenience, and affect the knowledge transfer speed, while dense local clustering means more repeated and redundant

Table 50.2 Panel negative binomial regression models with random effects (N = 2,025)

	$patents_{i\ t+0}$		
	1	2	3
presample5	0.001***(0.000)	0.001***(0.000)	0.001***(0.000)
partner-presample5	0.001***(0.000)	0.001***(0.000)	0.001***(0.000)
Density	−0.784(0.568)	−0.957(0.605)	−1.608*(0.606)
BC	0.005**(0.001)	0.001(0.003)	0.004(0.003)
Clustering		−0.142(0.252)	−1.103**(0.398)
Reach		0.065***(0.022)	−0.200**(0.091)
Clustering* reach			0.464***(0.151)
Constant	0.405***(0.085)	0.416*(0.222)	1.045***(0.299)
Log likelihood	−4624.089	−4619.446	−4614.521
	$patents_{i\ t+1}$		
	4	5	6
presample5	0.001***(0.000)	0.001***(0.000)	0.001***(0.000)
partner-presample5	0.001(0.001)	0.001(0.001)	0.001(0.001)
Density	0.214(0.601)	0.206(0.655)	−0.515(0.716)
BC	0.006**(0.002)	0.001(0.003)	0.004(0.003)
Clustering		−0.258(0.242)	−1.188**(0.383)
Reach		0.076***(0.022)	−0.194**(0.093)
Clustering* reach			0.467***(0.151)
Constant	0.357***(0.086)	0.448*(0.216)	1.067***(0.292)
Log likelihood	−4845.656	−4839.172	−4834.126
	$patents_{i\ t+2}$		
	7	8	9
presample5	0.001***(0.000)	0.001***(0.000)	0.001***(0.000)
partner-presample5	−0.001(0.001)	−0.001(0.001)	−0.001(0.001)
Density	1.551*(0.683)	1.603*(0.710)	1.000(0.782)
BC	0.005**(0.002)	0.004*(0.002)	0.007**(0.003)
Clustering		−0.171(0.237)	−0.915**(0.382)
Reach		0.007(0.024)	−0.223**(0.099)
Clustering* reach			0.381**(0.154)
Constant	0.367***(0.086)	0.489*(0.213)	1.000***(0.296)
Log likelihood	−4960.305	−4959.948	−4956.735

* represent statistical significance at the 10 % level.
** represent statistical significance at the 5 % level.
*** represent statistical significance at the 1 % level.

knowledge. In this case, it's hard to get abundant and novel knowledge even if firms spend high cost to engage in collaborative alliances. The two conditions both have adverse effects on firm innovation. Hence, relevant alliance policy makers should take the two aspects into consideration together. Before joining an alliance, firms must consider network structure attribute of the alliance network where they will be embedded, thus to get more diversified information.

Interfirm Collaboration relationships have significant impact on innovation performance of firms, and our results suggest that alliance networks may be an important mechanism of knowledge spillover. The cohesion and connectivity of alliance networks can enhance knowledge creation, and to some extent, our results have enriched the small-world network theory (Cowan and Jonard 2003).

The limitations of this study are mainly manifested in the following aspects. Firstly, our results are likely to be limited to industries that frequently employ alliances. In addition, different knowledge characteristics are capable of influencing the process of knowledge integration and creation (Zander and Kogut 1995), which we don't consider when we study knowledge transfer. Thus it is important for us to investigate the impact of these factors on knowledge creation and they are worthy of future development.

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Chapter 51
The Operation Mechanism of Open Innovation Community Network: A System Dynamics Model

En-jun Xia, Ming Zhang and Huai-jia Zhu

Abstract Environmental changes require that enterprises should actively seek more innovation methods and innovation modes. Based on the analysis of the open innovation community network system and the characteristics of its structure, from three aspects which are the knowledge transfer, the flow of human capital and innovation income growth, this paper integrates the system dynamics model of community networks of the open innovation system, and then analyzes its internal system integration, diversification of innovation income growth, and open innovation culture construction, which are the three key factors in the process of the network operation. We provide reference to the effective management of enterprises' value growth to improve the innovation performance and innovation abilities by the use of open innovation platform.

Keywords Network community · Open innovation · Operation mechanism · System dynamics

51.1 Introduction

Firms should use external as well as internal ideas, and internal and external paths to market, as they look to advance their technology, this process is called open innovation (Henry Chesbrough 2004). Existing literature have obtained a lot of results of research about open innovation from aspects such as external validity (Tom Poot et al. 2009; Ulrich 2010), commercial mode (Lorenzo 2010; BelussiFiorenza 2010; Sieg Jan Henrik et al. 2010), customer (Maria Antikainen et al. 2010; NeweyLance 2010) and network problem (LichtenthalerUlrich 2010;

E. Xia · M. Zhang (✉) · H. Zhu
School of Management and Economics, Beijing Institute of Technology, Beijing, China
e-mail: mingzhang225@163.com

E. Qi et al. (eds.), *The 19th International Conference on Industrial Engineering and Engineering Management*, DOI: 10.1007/978-3-642-38427-1_51,

Fichter 2009). But as a new innovation platform, online community network is rarely studied, also are the causal relationship between the various nodes and the integration mechanism of various innovation resources.

The System Dynamics (SD) method finds and studies various crucial factors within an overall system. Through the analysis of dynamic changes in the system and causal relationships, SD could solve complex problems under the condition of incomplete information. In the open innovation environment, cooperation, trust and mutual benefit relations arising in the process of acquiring internal and external resources, have integrated all members involved in the open innovation activities into a complex network system, which contains elements of all kinds of knowledge and information transmission loops, forming a lot of non-linear processes. So the method has sound applicability and predictabilities when studying open innovation community network.

Scholars have used the SD method to study different innovation networks. Junyan et al. (2011) have discovered the cooperative interaction between situational factors of research and production under open innovation environment with SD method. Guohong et al. 2011) established a system dynamics model of integrated innovation of production, teaching and research of high-tech cluster. Yang jian et al. (2010) established a basic structure of SD model of regional innovation systems. Chuanrong et al. (2010) have utilized SD model to predict key indicators of high-tech firms' innovation network and provided relevant suggestions to improve those indicators.

This article's second part will first analyze the characteristics of open innovation community network, on this basis in part III we then construct a SD model to describe the development and changes of open innovation community network system, exploring the running mechanisms within the system, in part IV we'll provide relevant recommendations to make effective use of the open innovation community network and maintain its healthy and sustainable operation, in order to improve firms' open innovation abilities. In the last part, some important views will be concluded.

51.2 The Characteristics of the Open Innovation Community Network System

1. *The number of network members is large and widely dispersed*: Members' wide distribution and participants' relevance in the innovation process will effectively guarantee so many benefits such as the concentrated use of both internal and external creative resources, faster internalization of external knowledge, faster knowledge integration processes, more dispersed innovation risks, lower innovation costs and faster innovation speed. This feature will also result in larger information sharing scope, more R&D opportunities, more effective knowledge transfer process and higher success rate of R&D activities.

In the open innovation process, the diversity of the participating subjects does not adequately indicate the attractiveness of the innovation community network. Meaningful discussion about innovation topics is an important indication of the network attractiveness. Only if there were enough members involved in the community construction and the number of member joined in the solving process of creative problems were maximized, would the innovation network be really attractive.

2. *The number of patents is the manifestation of the enterprise's knowledge stock*: Open innovation mode allows enterprises to acquire resources economically and effectively by transaction forms including but not limited to technology licensing, research contracting, technology mergers and acquisitions, strategic alliances or venture capital. Those ways help to reduce costs and risks of new R&D activities and improve firms' operation performance. The effective management and utilizing of intellectual property is very important during the trade activities above.

When studying on the relationship between the intellectual property system and open innovation, Chesbrough 2003) believed that enterprises under the open innovation condition must strive to become the buyer or seller of the intellectual property compare to the intellectual property strategy in the mode of closed innovation. Heap (2010) focused on Professor Henry Chesbrough's point of "open innovation: creating new demands, and profiting from technology" and concluded that open innovation needs to change the culture and also the attitudes towards intellectual property, which means that intellectual property assets are traded as valuable asset, not as a secret which is protected.

3. *Income from innovation is an important motivate of social network economic growth*: According to the economic theories, the output must be greater than the input to reflect the operate value of the network system. Otherwise, it won't survive long. In the open innovation system, enterprises can benefit from the income of technology trading through technology licensing, technology transferring or technology ownership trading when it has not commercialized all the patents. On the other side, patents represent results of some R&D stage, if some patents can better cater to market demands on new technologies or new products, then those commercialized patents can bring new products and improve enterprise's sales income. Therefore, under the condition of open innovation, enterprises' income sources are broadened by various trade objects including not only new products industrialized from patents like what traditional innovation model does, but also developed patents whose commercialization conditions are not so sufficient within domestic organisation. That is to say, firms are more flexible in open innovation when doing with R&D activities.

51.3 System Dynamics Model for the Open Innovation Community Network

1. *System boundaries*

System Dynamics believed that internal factors determines the system behavior, external factors often play less decisive roles, so it is a key step to choose reasonable boundaries for our ideal SD model. In this paper, we think that the open innovation community network system is composed of three subsystems including knowledge transfer and flow subsystem, human capital flow subsystem and innovation income growth subsystem. The three subsystems connect with each other by key variables like number of network members, number of patents and innovation income. These three subsystems which are divided from the whole system determine and maintain the running mechanism of the community innovation network system, so we'll analyze each subsystem' respectively and then the whole system's running mechanism is inferred.

2. *Basic assumptions*

H1: Community networking system is consisted of a series of continuous and gradual open innovation activities.

H2: Changes caused by significant policy changes, natural disasters and other unforeseen emergencies will not be taken into account.

H3: Input of open innovation activities include research and development funds, material rewards for innovative staff, human capital and intellectual capital, innovation outputs included patents, innovation income and so on.

3. *Causal diagrams*

As the Fig. 51.1 shows, variables like number of network member, innovation revenue, number of patents and open innovation culture are key hubs to maintain the innovation system's running processes. They connect with various nodes influencing and interacting with each other, forming a healthy dynamical system by knowledge transfer and flow mechanism, human capital flow mechanism and innovation income growth mechanism.

Innovation revenue achieved by the network system guarantees the distribution process of members' interests and strengthens incentive effects on network members. While it can enlarge the reputation of the innovation network and attract more new members, and more network members make the network more influential and show better image to the public. On the other hand, when network members are more enthusiastic, they are usually more inclined to practice their expertise, innovation potential and sense of cooperation. And these factors will strengthen R&D collaboration effects within the innovation network.

If the innovation network becomes significantly more attractive, the innovation related subjects will put more human and financial resources into the system and provide more material securities for open innovation activities. More innovation

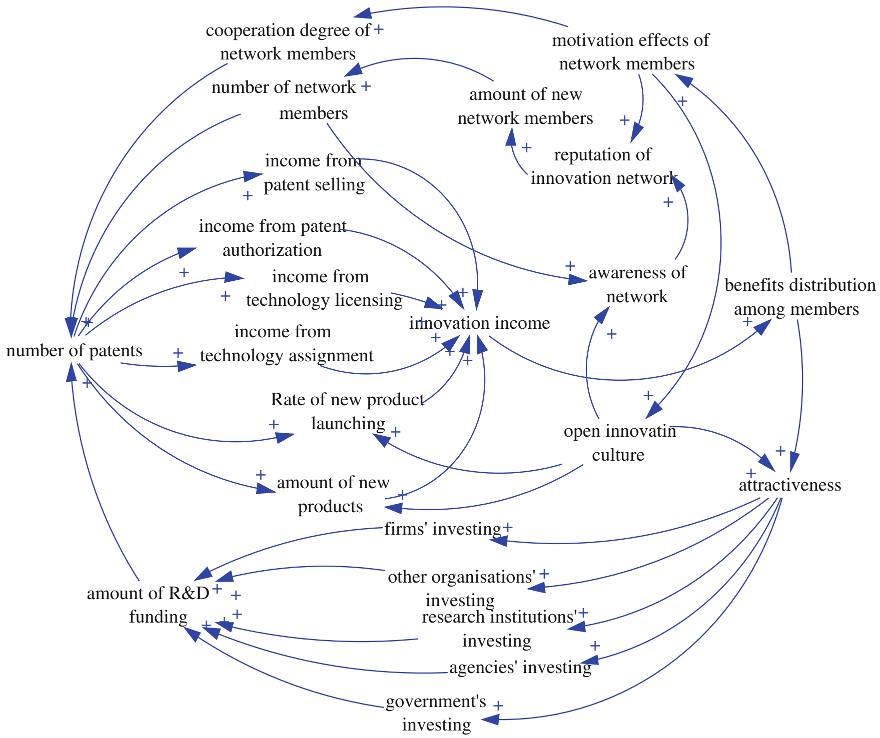


Fig. 51.1 The SD causal diagram of open innovation community network

funding, more participating network members and enhanced collaboration effect will function together to product more patents, which are the most important knowledge form of one firm's innovation performance. And if patents are able to adapt to the complex and rapid changes of market demands, then enterprises' new products will create more considerable revenue, on the basis of which the entire innovation network system can operate more sustainably.

4. *Knowledge transfer and circulation system*

Community network includes a variety of knowledge flows in forms like patents, technology, experience, ideas and other things either dominant or hidden. In the process of open innovation, the rate variable called increasing number of patents directly affects the number of patents which is the basis of the commercialization and marketing of enterprise intellectual property. This means that enterprises can either transform patents or technologies into new products through industrialization, or directly trade with other organizations through ways such as technology transfer or technology licensing whose trade objects are intellectual properties. The increasing number of patents has been directly affected by variables like the number of experts or research institutions involved in innovative projects, members' professional qualities and comprehensive capacities, and also

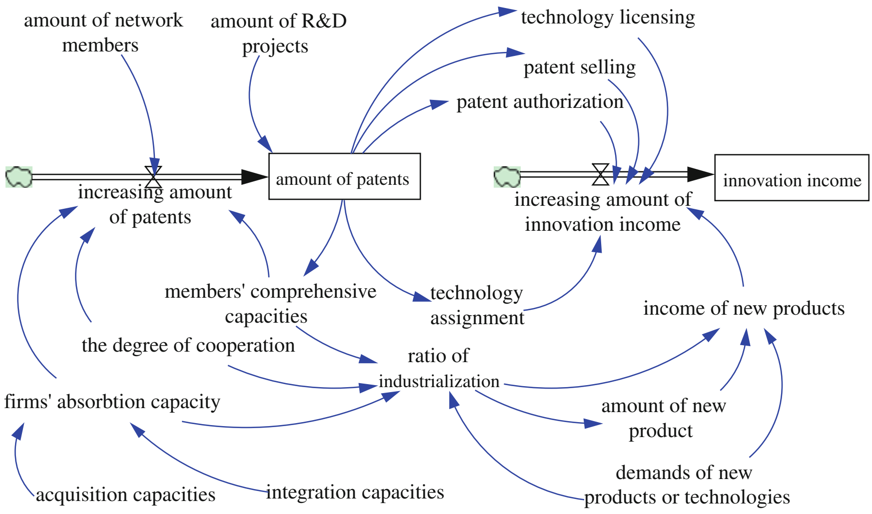


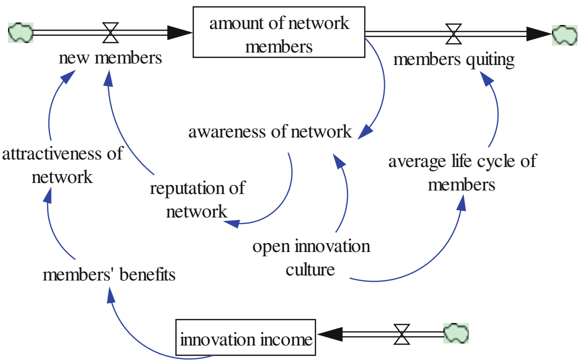
Fig. 51.2 The SD flow diagram of knowledge transfer and circulation

enterprise's absorptive capacity for the outside knowledge or ideas. Enterprise's absorption capacity is primarily determined by the acquisition abilities of external knowledge and the abilities that make external knowledge integrated into independent forms of knowledge for the enterprise. The number of patent, mainly controlled by the increasing number of patent, not only increases firms' revenue by such transaction ways as technical trading, technology licensing, technology transfer, but also meets members' self-worth realization and other high level needs. The function will stimulate the community innovation power from the members of the network and improve their innovation capacities. The auxiliary variable patent industrialization rate is determined by the level of market demands for new technologies or new products, professional and comprehensive abilities of the network members and cooperation degree between innovation subjects (Fig 51.2).

5. *Mechanism of human capital flow*

The human capital flow is an important channel for the transfer of technology, knowledge and innovation ideas in open innovation system. The state variable number of community members is mainly regulated by two rate variables the number of new members and the number of quitting members. The number of newly joined network members is restricted by the innovation network reputation and the attractiveness of community network. Community network attractiveness can consolidate open innovation culture foundation and cause for more widely concern. It is directly affected by the distribution of network members' interests, which is mainly determined by improving innovation income. Innovation network reputation is established on the foundation of the network's popularity, which increases gradually as the number of network members expands continually.

Fig. 51.3 The SD flow diagram of mechanism of human capital



On the other hand, the cultivation of open innovation culture is also an important factor to influence the network's popularity. Sound open innovation culture brings those advantages like creating a good innovative atmosphere, enhancing the belonging sense among those network members, expanding the influence of innovation network and increasing its visibility. The number of member who quit from the network is mainly affected by the members' average community life cycle. Generally those members who have not sufficiently understood the innovative activities and those who are not able to make a positive contribution usually tend to leave the network as their network life cycles end. Members' average life cycle is also under the influence of open innovation culture. Innovation benefits distribution from the innovation income and cultivation of open innovation culture are the key links in the formation process of human capital flow mechanism, if the number of the network members continues to increase and maintains relatively stable, then the patent number and innovation revenue growth will be better secured. This shows that human capital flow provides an important impetus for the mobility of the open innovation community network (Figs 51.3, 51.4, 51.5).

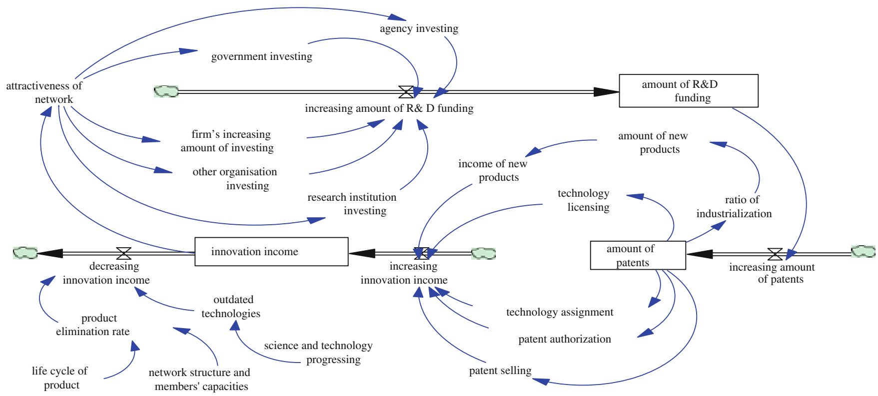


Fig. 51.4 The SD flow diagram of innovative revenue growth mechanism

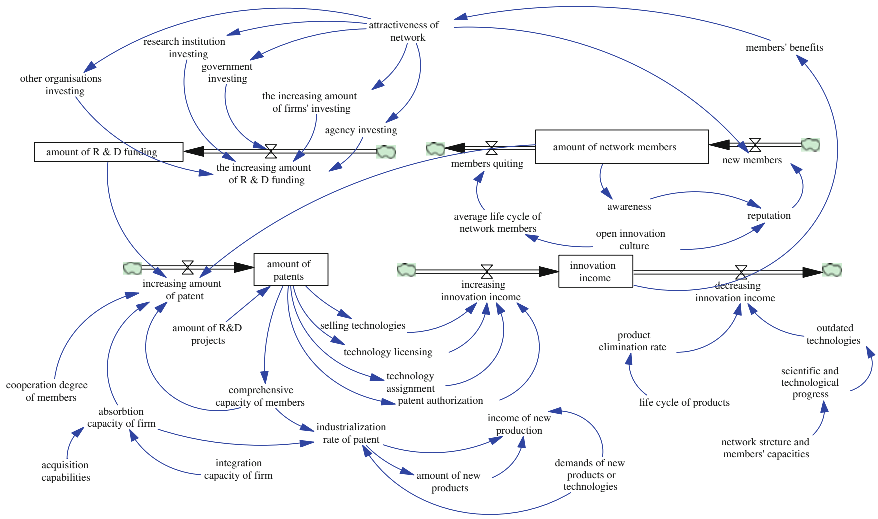


Fig. 51.5 The SD flow diagram of open innovation community network system

6. *Innovative revenue growth mechanism*

Innovation revenue growth mechanism mainly refers to the comparison between the input to the innovation systems and economic outputs. In the course of system input–output, input of funds from various creators is necessary, but what is more important is the knowledge flows, technology flows, human capital flows and other factor flows resulting from the movement of financial flows. The innovation revenue is largely driven by two rate variables: the increasing innovation income and decreasing innovative income. The former is largely driven by the trade of intellectual property and product resulted from the industrialization of patents. If auxiliary the demands of intellectual properties and patents industrialization ratio are relatively stable, then on one side the opportunities of technology transfer, patent authorizing, and other ways of intellectual property trading will increase, on the other side the increasing new products can bring the improvement of innovation products income, motivating more inputs into the R&D projects from all the network members. R&D inputs include funds and human capital inputs from enterprises (including competitive enterprises and other enterprises upstream and downstream, government inputs, and research institution inputs, intermediate agent's inputs and other aspects such as inputs from users and experts). Increased investment ensures adequate funding of the R&D system. Under the condition of open innovation culture and higher comprehensive capacities of the network members, enterprises' patents will have a significant growth, thereby creating more innovative revenue and bringing more interests to innovation participants. The reducing innovative revenue is largely due to obsolete products and outdated technology, which are usually caused by advanced science and technology and consumers' ever-changing demands.

51.4 Discussion

1. *Focus on the integration of human capital, intellectual capital and financing*

Human capital is the most important resource in the innovation community network. The funding capital flows and intellectual property flows are all the results of the process of continuous human capital movement and value-creating.

Intellectual property capital is a key carrier in the open innovation process. It is the output of human capital and funding investment, and also the important basis or power for subsequent financial flows.

Financial flow is the necessary security for the sustainable operation of the open innovation community network. On one hand, to accumulate the intellectual capital needs continuous funding investment, then new intellectual capital creates more value and also generates more funds, further promoting the continued growth of intellectual capital, On the other hand, financial flow is also an important physical factor to encourage community members to develop innovative potential and promote research and development dynamics.

Therefore in the construction and operation process of open innovation community network, firms should pay attention to the interactive relations between human capital, intellectual capital and money capital. Their managing work should focus on the integration of various elements within the innovation network system, in order to ensure the healthy and sustainable running of the open innovation community network.

2. *Expanding various innovative revenue growth forms*

In traditional innovation mode, if a project is found that could not immediately bring tangible benefits to the enterprise in its internal inspection process, then the company wouldn't do more about the project or work, and there is no reason to doubt that the termination of the project or work may be caused by the system errors during the evaluation and estimating processes, such errors are called "false negative" (false negative) by scholars. And if a project is predicted to have a very good market attractiveness in the feasibility analysis process, and companies put a lot of R&D costs into the project, and make it commercialized, but actually the results are proved to be very disappointing, that is the so-called "false positive" (false positive) (Chesbrough 2004). In the open innovation activities, due to the widely distributed creators and the timely and effective testing conducted by the market, firms usually can avoid "false positive" errors. Through trading forms like patent authorizing, technology licensing, patent selling and technology transferring, enterprises make projects or patent that don't have application value at first much more valuable, and create more income opportunities to avoid "false negative" errors' occurrence. However, we found "false positive" and "false negative" errors are mutually exclusive, that is to say, reducing one kind of error will inevitably lead to the increasing of occurrence of another kinds of error. In fact enterprises tend to avoid "false negative" errors, because increases in the number of patents cannot bring more innovative products revenue simultaneously, so we can make more innovation income as much as possible through the intellectual property trading market.

3. *Fostering open innovation culture*

To increase the attractiveness of the innovation network, members need to spend more costs on hardware resources like the community environment and innovative funding; what needs more attention is the construction process of innovation atmosphere and open innovation culture. An open, comprehensive innovation culture is the result of the cooperation, trust and respect between various participants. Healthy innovation culture is helpful for highlighting the value of human capital, increasing the sharing rate of community network information, accelerating the transfer and diffusion speed of innovation knowledge, and enhancing community members' learning abilities and their industrialization abilities of scientific research. When managing and running the open innovation network community, enterprises need to play a guiding role in the processes like actively attracting all possible social capital, taking available measures making innovative culture rooted in the hearts of all the staff and community members, intensifying the attractiveness of community network, and promoting economic growth of open innovation network.

51.5 Conclusion

Open innovation community network is a higher-order complex social system containing multiple circuits and large amount of information flows. Through the analysis on subsystem networks of knowledge transfer flow, human capital flow and innovation income growth, we concluded three key measures for improving the growth of open innovation community network economy. First, firms should pay attention to the integration of the interactive relationships between human, material and financial resources in the internal system. The second is that firms should try to widen the growth channels of innovation income and the last is focusing on cultivating open innovation culture. Then healthy and sustainable operation of open innovation community network can be maintained.

As the sense of open innovation has not been adopted by the most firms in China, we need more studies on the government and excitation about the open innovation community network. By the side, related data cannot be collected easily, so future studies can collect relevant data to test the reliability of the models.

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Author Biography

En-jun Xia is professor of School of Management & Economics in Beijing Institute of Technology. Research area: Technology innovation, regional economic.

Chapter 52
The Different Impact of Innovative Human Capital and R&D Subsidy on the Technological Progress: An Empirical Study Based on Zhejiang

Yi-bing Tang, Li-jun Meng and Cheng-xia Hu

Abstract How to promote the construction of innovative province: to improve the supply of innovation human capital or R&D incentives? Based on the time-series data in Zhejiang province during the period 2003–2009, the empirical analysis showed that supply of innovative human capital have a significant promoting effect on technological innovation and technological advance, while the effect of R&D encouraging policy is much less than that of supplying innovative human capital. The implication of policy is obvious: the policy of improvement in the supply of innovative human capital should be preferred to promote R&D-based economic growth, and the policy of stimulating the demand of R&D should be conduct on the condition that the supply of innovative human capital is elastic.

Keywords Innovative human capital · Science and technology policy · Technological advance

52.1 Introduction

R&D subsidy policies that inspire R&D needs have a long-term growth effect, which is an important conclusion based on endogenous growth researches. The endogenous growth researches confirmed that the technological progress could promote economic growth, and technological advance depended on firm's R&D

Y. Tang (✉) · L. Meng · C. Hu
School of Economics and Management, China Jiliang University, Hangzhou, China
e-mail: tangyangtony@163.com

L. Meng
e-mail: snowwhite@zju.edu.cn

C. Hu
e-mail: hcx115@163.com

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investment. R&D subsidies would encourage firm to invest more R&D resources in the horizontal and vertical innovation, therefore promote economic growth. Romer(1990), Aghion and Howitt (1992) have found that R&D subsidy encourage firm's R&D investment, thus improve long-term economic growth rate (Romer 1990) (Aghion and Howitt 1992). The policy that indirectly stimulates the firm's R&D needs could also promote the long-term economic growth, Rivera-Batiz and Romer (1991) holded that reduction of tariffs could lead to the improvement of world economic growth (Rivera-Batiz and Romer 1991). Based on these theory results, every country can encourage R&D investment through R&D subsidies and tax incentives.

However, Jones (1995) questioned the above results and suggestions (Jones 1995). He pointed out that the endogenous growth model has the feature of "economic of scale", that is to say, the more R&D resources are invested, the faster the economic growth is, but this is unrealistic. Since 1950, the amount of scientists and engineers involved in R&D of France, Germany, Japan and the United States is increasing rapidly, but the growth rate of per-capital income does not show upward trend. R&D subsidies had expanded the relative size of the R&D department, but it did not affect the long-term growth rate. Segerstrom (1998) obtained the same conclusion based on the analysis of vertical innovation model, while the analysis in the framework of horizontal and vertical tow-dimensional innovation, R&D subsidies even reduced long-term growth rate (Segerstrom 1998). Segerstrom (2000) and Young (1998) found that R&D subsidies had no long-term growth effects based on horizontal and vertical innovating model analysis (Segerstrom 2000) (Young 1998). Howitt (1999) showed that the effect of R&D subsidies on long-term economic growth is not clear (Howitt 1999).

If the R&D subsidies cannot promote economic growth, then what kind of policy can promote effectively R&D-driven economic growth?

On one hand, R&D subsidy policy impacts R&D-driven economic growth, but in order to analyze the effect of this policy on economic growth, we need to know how R&D subsidies impacts technological progress. Generally, technological advance has two main patterns, namely, innovation and imitation, all of these patterns promote economic growth together. In some countries, such as Japan, imitation has made extremely important contributions to economic growth (Rosenberg and Steinmueller 1988). Innovation and imitation promote mutually and restrain mutually in the process of technological advance; On the other hand, innovation develops new technologies, and increases the amount of the technologies available to imitate; while imitation also contribute to the promotion and application of innovative technologies. On the other hand, the technology breakthrough made by innovation reduces income of imitation investment previously. At the same time, imitation has also stimulated demand of innovative investment through enhancing market competition. The relationship between innovation and imitation and the policy effects on encouraging technological progress (such as innovation subsidies, imitation subsidies and intellectual property protection) have been the hot issues in endogenous growth literature recently. Whether using partial equilibrium analysis method or general equilibrium analysis method, innovation subsidies improved the strength of innovation and reduce imitation strength. But by using a dynamic general equilibrium model, Segerstrom (1991) obtained diametrically opposite conclusion (Segerstrom 1991). Davidson and Segerstrom's (1992) analysis also showed that strengthening the degree of patent protection reduced innovation intensity in the steady-state equilibrium and improved imitation strength (Davidson and Segerstrom 1992). This conclusion has been questioned by Cheng and Tao (1999), they believed that the hypothesis of linear-technology production function led to this counter-intuitive conclusion (Cheng and Tao 1999). Since there are reciprocal relationship of R&D subsidies on innovation and imitation, the relationship between R&D subsidy policy and innovation and imitation may be an important factor that leads to R&D-driven economic growth.

On the other hand, the supply of R&D resources is an important factor, which also affects the R&D-driven economic growth. Generally, it is widely recognized that human capital is a basic input element of R&D. More importantly, R&D requires specific innovative skills, and these innovative skills embodies in scientists and engineers, who have a significant positive relationship with R&D output. The success of R&D depends on the innovative skills of scientists and engineers rather than R&D investment (Leiponen 2005). The lack of innovation skills is a major obstacle to innovation (Mohnen and Röller 2005). Colombo and Grilli (2005) examined the impact of specific human capital and general education of entrepreneurs on the growth of high-tech industries, and found that the average education years of entrepreneurs has no significant impact on firm growth, while scientists and engineers education have an significant positive effect on firm growth (Colombo 2005). Since the specific innovative skills embodied in scientists and engineers are main factors that determine the success of R&D, thus improving the efficiency of innovative skills is expected to promote R&D-driven economic growth.

52.2 Data and Selection Stationarity Test

52.2.1 Data Selection and Processing

The data used in this study came from the Zhejiang Statistical Data Compilation of 60 Years, Zhejiang Statistical Yearbook and Zhejiang Science and Technology Statistical Yearbook from 2003-2009. the following time series are mainly used in our paper: (1) the amount of patent application quantity (CHXING), on behalf of technology innovation; (2) the number of scientists and engineers (INCAP), a measure of the core R&D resources of Zhejiang province; (3) science and technology financial funds (YFJL), on behalf of the R&D input indexes of Zhejiang province; (4) Malmquist technological progress index (TECHPRO). Malmquist productivity index is calculated by using the data envelopment analysis (DEA), the decomposition indicators of technological progress index measured on behalf of the technological progress, technical boundaries of the period move from t to t + 1 using on-front 2.0 software to calculate the Malmquist technical progress index.

52.2.2 Testing of Time Series Stationarity

Before the test, we use the ADF unit root algorithm to test the stationarity of each variable. Test results are shown in Table 52.1.

In Table 52.1, it is shown that LINCAP, LYFJL, LCHXING, TECHPRO sequences are all non-smooth, and their first-order difference sequence are stationary, so all variables are I(1) sequence.

52.3 Empricial Test Results

Co-integration test uses the way of EG two-step, the two co-integration equation to be tested can be written as:

$$\mathrm{LCHXING_t} = b_0 + b_1\mathrm{LINCAP_t} + b_2\mathrm{LYFJL_t} + \mu_t \tag{52.1}$$

$$\mathrm{TECHPRO_t} = c_0 + c_1\mathrm{LINCAP_t} + c_2\mathrm{LYFJL_t} + \mu_t \tag{52.2}$$

According to the co-integration test of the trace statistic test methods, co-integration tests begin from the null hypothesis that co-integration relationship does not exist (Table 52.2). For (1), beginning from the null hypothesis, r = 0, track statistics value is 43.22005, it is greater than the 5 % significance level critical, 35.19275, That should be rejected the null hypothesis H0: r = 0, accept the alternative hypothesis, H1: r $\gg$ 1. In the next test, null hypothesis, r $\ll$ 1, is

Table 52.1 Unit root test results

Variable	Testing form (C,T,K)	ADF testing	
		ADF statistics	Critical value
LINCAP	(C,T,1)	−2.15	−3.23(10 %)
LINCAP	(C,N,1)	−4.73	−3.72(1 %)
LYFJL	(C,T,1)	−0.54	−4.36(5 %)
LYFJL	(C,N,0)	−3.41	−2.98(5 %)
LCHXING	(C,T,2)	−3.28	−3.60(5 %)
LCHXING	(C,N,0)	−5.39	−3.71(1 %)
TECHPRO	(N,N,2)	0.79	−1.61(10 %)
TECHPRO[a]	(N,N,1)	−5.07	−2.66(1 %)

Notes (C,T,K) denotes constant term in the equation of the unit root test, time trend and the lag order respectively; N does not include C or T; K value of the minimum criteria based on AIC and SC select; [a] denotes the difference operator

Table 52.2 Co-integration test results

	Null hypothesis	Alternative hypothesis	Track statistics value	Characteristic value	5 % Critical value	Lag interval
Test1	$r = 0^a$	$r \gg 1$	43.2	0.61	35.19	(Romer 1990)
	$r \ll 1$	$r \gg 2$	18.5	0.41	20.26	
	$r \ll 2$	$r = 3$	4.71	0.17	9.16	
Test2	$r = 0^*$	$r > 1$	98.6	0.87	54.08	(Romer 1990; Aghion and Howitt 1992)
	$r \ll 1^*$	$r \gg 2$	50.0	0.66	35.19	
	$r < 2$	$r \gg 3$	24.3	0.55	28.26	

Notes [a] denotes rejection of the null hypothesis at the 5 % significance level; critical value is given by the software Eviews5.0

accepted on the 5 % significance level, which shows that there is a co-integration relationship between variables at the 5 % significance level. According to the same method, the two co-integration relationships of (2) are determined.

For the first test, (3) can be written as:

$$\mathrm{LCHXING_t} = 6.10\mathrm{LINCAP_t} - 2.99\mathrm{LYFJL_t} - 7.42 \tag{52.3}$$

$$\begin{array}{cc} (0.96088) & (1.8606) \\ [-6.35366] & [1.8125] \end{array}$$

Similarly, for the second test, (4) can be written as:

$$\mathrm{TECHPRO_t} = 0.87\mathrm{LINCAP_t} + 0.37\mathrm{LYFJL_t} - 1.80 \tag{52.4}$$

$$\begin{array}{ccc} (0.24112) & (0.23686) & (0.06078) \\ [-2.9444] & [-1.5404] & [2.95415] \end{array}$$

Each co-integration equation shows that the increase in the number of scientists and engineers can significantly promote technological innovation and technological progress in the long time, Scientists and engineers is the main driving force of technological innovation and technological progress. The number of Scientists and engineers increases one percentage point will promote technological innovation by 6.105 % points, and promote technological progress by 0.873 % points. The national financial funding of simulating R&D needs has no significant to technical innovation and technological progress. Test results of Granger causal relationship listed in Table 52.3. We can see the short-term causal relationship between variable from it.

Table 52.3 shows that the null hypothesis 1, 2, 3 be rejected, suggesting that the increase in the number of scientists and engineers is due to innovation and technological progress. According to the empirical analysis of Zhejiang, we can get the following conclusion: The effect of Zhejiang's science and technology policy simulating R&D needs is far less than the effect of innovation manpower supply.

Table 52.3 Granger causal relationship test results

Serial	The null hypothesis	F	P	X2	P	Conclusion
1	$\theta 2 = \theta 3 = 0$	10.47	0.008	20.94	0.00	Rejection
2	$\theta 4 = \theta 5 = 0$	0.39	0.69	0.79	0.67	Acceptation
3	$\gamma 2 = \gamma 3 = 0$	10.47	0.008	20.94	0.00	Rejection
4	$\gamma 1 = \gamma 2 = \gamma 3 = 0$	31.70	0.0002	95.10	0.00	Rejection
5	$\gamma 4 = \gamma 5 = 0$	0.85	0.47	1.69	0.43	Acceptation

Notes the parameter constraints test using by Wald test

That is, the national financial funding of simulating R&D needs has no significant to technical innovation and technological progress.

52.4 Conclusion

In this paper, based on an Empirical Study of Zhejiang, the following conclusion is made: increasing supply of innovation manpower has distinct effects on technological innovation and technical advance. While the effect of science and technology policy of stimulating R&D needs is much smaller than that of increase in the supply of core R&D resources. The guiding significance of the theory results on economic development in Zhejiang province is mainly embodied in: the policy priority of promoting technical progress should focus on enhancing the supply of R&D resources, especially improving the quality of scientists and engineers training. In the process of "constructing the innovative province", if Zhejiang province increases innovation demand without considering the supply of corresponding innovative human capital provided by higher education system, the policy effect might make income equality increasing, but the growth effect will not obvious. In the past ten years, Zhejiang province's R&D expenditure of stimulating R&D demand was growing rapidly, but the science and technology policy of stimulating R&D did not significantly improve the efficiency of independent R&D. Therefore, in order to promote the construction of the innovative province, science and technology policy should focus on the training of innovation talents, increasing the government fiscal expenditure of innovative human's cultivation, and improving the training efficiency and quality of innovative human.

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Chapter 53
An Incentive Mechanism for Knowledge Sharing in Research Team

Huo-di Zhu, Yan Liu and Bu-yu Xu

Abstract This paper focuses on the incentive mechanism for knowledge sharing in Research team. The team is assumed to be constituted by two members (the first member and the second member). The team's output is affected not only by the efforts of the first member (S1) and the second member (S2), but also by the core competitive knowledge of the second member (K2). Making use of game theory, we construct a multitasking model for team members' inputs that analyzes three decision variables that influence team members' knowledge sharing. And make a series of profound conclusions that related to team cooperation. These conclusions are important and instructive to research team building and team performance improvement.

Keywords Game theory · Knowledge sharing · Mechanism design · Research team · Team performance

53.1 Introduction

The team is the alliance of groups that composed of members of the heterogeneity of complementary skills who committed to a common purpose and performance goals, and to assume certain responsibilities. Modern management thinking are all pointed out and stressed that the future organization form must be a dynamic team with energy. The key is team members should be multiskilled "generalist", enjoy a high degree of autonomy and decision-making flexibility, and share their unique knowledge for the research team building and team work performance.

H. Zhu (✉) · Y. Liu · B. Xu
ChongQing University of Technology, ChongQing, China
e-mail: zhuhuodi@sohu.com

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Most of the literature on team research focuses on the formation of research teams, on the team building and the importance that. However, the reality is the teams' operating are not satisfactory, there is a problem of high failure rate among them. A large number of failed cases show that the there are still some gap between theoretical research on the team and team management. The reason why the team is existed lies in its ability to gain advantage from cooperative members in achieving growth and manage risk. In essence, team through collaborative create value or mutual benefit income, that partners alone can not achieve. So part of the reason to form the team is due to the formation of the value of the partnership.

Thus, the expected synergies can not be achieved is a major cause of team failure.

Empirical studies of Chan and Kensiger (1997) have shown that, when the transfer of technical knowledge or technical knowledge exchange is involved, the Union can gain more value. Therefore, the Union's success depends on member's willing to share its proprietary knowledge with the others in it. In an alliance, alliance members may be more active to share noncritical knowledge of the performance than critical knowledge of its core competitiveness of the performance. Chen and Fan (2007) pointed out that the instability of the Union will rise with the expansion of the difference in degree of cooperation and competition between the forces within the Union. Taking into account the potential long-term cost, knowledge sharing of the League members is a very important decision. But because Union may be dissolved at any time, if the know-how was easily learned and mastered by other members of the Union, the members presently possessed it would face the danger of losing their competitive advantage.

In the research on factor affecting knowledge sharing, there are "hard" aspects, such as technology and tools (Albino et al. 2004; Cabrera et al. 2006; Kwan and Cheung 2006); and also "Soft" aspects of cooperative motive, (Ardichvili et al. 2003) mutual trust between alliance members (Levin and Cross 2004), Corporate culture (Hlupic et al. 2002), and technology absorptive capacity and other factors (Cohen and Levinthal 1990). Research in knowledge-sharing mechanism, Gupa and Govindarajan (2000) studied the knowledge sharing in multinational corporations; Simonin (1999) studied the knowledge sharing process between the strategic partners; Lyles and the Salk (1996) focused on how the international joint ventures access to knowledge from their foreign partners; Griffith (2001) got used of the central unit and absorptive capacity of the network to discuss knowledge sharing within the organization; Zhuang and Li (2004) submitted a general pattern, the formation mechanism and income distribution program of quantitative knowledge share.

Recent research of knowledge-sharing focused on how the agent decides whether to transfer knowledge to team members. Lazear (1981), Itch (1992) studied the production of every member of the group need to make a choice between complete their own tasks and assist partners. Holmstrom and Milgrom (1982, 1994), Baker (1992) approach to the extensions for each agent can perform a any number of tasks. Holmstrom and Milgrom (1994), Itch (1992) showed how job design and task allocation will change the choice of agents in multitasking environment. As the Itch (1992) studied that, relatively monotonous tasks may reduce the cost of agents to help others, for example, to impart knowledge may simply break up the monotony. By the same token, engaged in more complex tasks may make agents feel cumbrous in the transfer of knowledge.

This article will use a multitasking principal-agent framework to induce team members to fully share proprietary knowledge with core competitiveness by setting incentive targets.

53.2 Model Construct

Assume that the team is made up of two members.

The team's output is affected not only by the efforts of the first member (s_1) and the second member (s_2), but also by the impact of the core competitiveness knowledge of the second member (k_2). Therefore, the team's production function model is:

$$F = f(s_1, s_2, k_2) \tag{53.1}$$

Assume the output of a special form team can be expressed as:

$$F = (1 + \lambda k_2)(s_1 + s_2) \tag{53.2}$$

Among them, λ is the sensitivity of k_2 to the influence on the team output. $0 \leq \lambda \leq 1$.

Equation (53.2) depicts the team output model by the individual efforts of the first member (s_1), and the multiple efforts of the second member (s_2, k_2). For convenience of analysis, as assuming that k_2 was a duality decision variable, and its value was 0 or 1. Marginal productivity of s_1 and s_2 is increased by the effort of k_2, when the second member contributes $k_2(k_2 = 1)$, take $\lambda = 1$, the team's output doubled. It is worthwhile to pay attention that the team still has a positive output when $k_2 = 0$. Next, we could get team production signal (Such as team production):

$$\begin{aligned} &P = (1 + \lambda k_2)(s_1 + s_2) + \varepsilon \\ &\text{And } \varepsilon \in N\left(0, \sigma^2\right) \end{aligned} \tag{53.3}$$

When considering the other factors of the environment that affect the level of team output, we assume that the team output follow a normal distribution: $N(0, \sigma^2)$.

Assume that the revenue of the second member after it joins in the team (Based on linear incentive model) may be expressed as:

$$Q = M + IP$$

where Q is the total receipts of the the second member; M is the fixed income of the second member; I is the incentive level, $0<I<1$; P is the team output performance indicator (such as output, output value, etc.)

Assume that a cost of effort of the first member is:

$$C(s_1) = s_1^2/2 \tag{53.4}$$

For the second member's multiple inputs, we assume that the cost function as follows:

$$C(s_2) = s_2^2/2 + \phi k_2 \tag{53.5}$$

In Eq. (53.5), ϕ is the cost of the second member's contribution knowledge, $\phi > 0$; Quadratic part is the same efforts' cost of the second member as that of the first member.

Therefore, the expected utility of the second member can be expressed as:

$$\begin{aligned} CE_2 &= E(Q) - s_2^2/2 - \phi k_2 - rI^2\sigma^2/2 \\ &= M + I(1 + \lambda k_2)(s_1 + s_2) - s_2^2/2 - \phi k_2 - rI^2\sigma^2/2 \end{aligned} \tag{53.6}$$

where, r represents the members' value of risk aversion. The first member hope he could control s_1, s_2 and k_2 through choosing M or I, in order to maximize its expected utility, i.e. a maximization of the difference between the expected revenue and negative utility $\left(s_1^2/2\right)$ and the compensation for the second member. Assume that the second member's reservation utility was zero ($\underline{U} = 0$), the first member can be expressed as follows:

$$\begin{aligned} &\underset{M,I}{Maxmize} E(F - s_1^2/2 - Q) \\ &\quad s.t\ E(Q) - s_2^2/2 - \phi k_2 - rI^2\sigma^2/2 \geq 0 \\ &\quad\quad s_2, k_2 \in \arg\max\left[M + I(1 + \lambda k_2)(s_1 + s_2) - s_2^2/2 - \phi k_2\right] \\ &\quad\quad s_1 \in \arg\max\left[(1 + \lambda k_2)(s_1 + s_2) - s_1^2/2 - (M + I(1 + \lambda k_2)(s_1 + s_2))\right] \end{aligned}$$

In the optimization model, the first member need not pay the second member more than the second member's reservation utility. Therefore, the model sets participation constraints, and brings out the total receipts of the second member from the angle of the risk premium and the cost.

Therefore, the first member problem can be simply expressed as:

$$\underset{M,I}{Maxmize}\, F - s_1^2/2 - s_2^2/2 - \phi k_2 - rI^2\sigma^2/2 \tag{53.7}$$

$$s.t. \quad s_2, k_2 \in \arg\max\left[M + I(1 + \lambda k_2)(s_1 + s_2) - s_2^2/2 - \phi k_2\right] \tag{53.8}$$

$$s_1 \in \arg\max\left[(1+\lambda k_2)(s_1+s_2) - s_1^2/2 - (M + I(1+\lambda k_2)(s_1+s_2))\right] \tag{53.9}$$

53.3 The Information Solution When Team Members' Effort Level can be Observed

Assume that the efforts of two members were observed, (For example, in the absence of bilateral moral hazard problem) the first member's optimal result could be achieved through paying the second member that equal to the rewards reservation utility plus the cost of effort. With these assumptions, the first member can be stated as:

$$\underset{s_1,s_2,k_2}{Maxmize}(1+\lambda k_2)(s_1+s_2) - s_1^2/2 - s_2^2/2 - \phi k_2 \tag{53.10}$$

53.3.1 The Optimal Level when $k_2 = 1$

When the second member contributes its knowledge, we could yield the optimal solution to the efforts of two members and the receipts of the first member according to Eq. (53.10):

$$\begin{aligned} s_1^* &= 1+\lambda \\ s_2^* &= 1+\lambda \\ H_{k_2=1}^* &= (1+\lambda)^2 - \phi \end{aligned}$$

53.3.2 The Optimal Level when $k_2 = 0$

Meanwhile, according to Eq. (53.10), we can yield the optimal solution to the efforts of two members and receipts of the first member when the second member does not contribute its knowledge:

$$\begin{aligned} s_1^* &= 1 \\ s_2^* &= 1 \\ H_{k_2=0}^* &= 1 \end{aligned}$$

The first member in order to make $k_2 = 1$, If and only if

$$\begin{aligned} & H^*_{k_2=1} \geq H^*_{k_2=0} \\ & \Rightarrow (1+\lambda)^2 - \phi \geq 1 \\ & \Rightarrow \phi \leq \lambda(\lambda + 2) \end{aligned}$$

Therefore, we define the upper limit of ϕ as $\lambda(\lambda + 2)$.

53.4 The Information Solution when Team Members' Effort Level can not be Observed

Further, to examine the more realistic situation, that is, team members' efforts level can not be directly observed, but the team's output P can be observed.

From the constraints (53.8), obtaining the first-order condition is:

$$s_2 = I(1 + \lambda k_2) \tag{53.11}$$

From the constraints (53.9), obtaining the first-order condition is:

$$s_1 = (1 - I)(1 + \lambda k_2) \tag{53.12}$$

Therefore,

$$s_1 + s_2 = 1 + \lambda k_2 \tag{53.13}$$

According to the conditions (53.8), considering marginal revenue and cost of the second member contribution variable k_2, we can obtain the following relationship:

If $k_2 = 1$, then

$$\begin{aligned} & I\lambda(s_1 + s_2) \geq \phi \\ & \Rightarrow I \geq \phi/\lambda(s_1 + s_2) \\ & \Rightarrow I \geq \phi/\lambda(1 + \lambda k_2) \\ & \Rightarrow I \geq \phi/\lambda(1 + \lambda) \end{aligned} \tag{53.14}$$

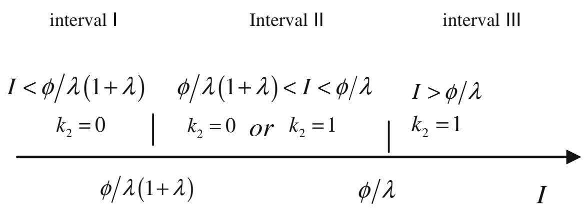

Fig. 53.1 Situation of motivating the second member to contribute knowledge

If $k_2 = 0$, then

$$\begin{aligned} & I\lambda(s_1 + s_2) < \phi \\ & \Rightarrow I < \phi/\lambda(s_1 + s_2) \\ & \Rightarrow I < \phi/\lambda(1 + \lambda k_2) \end{aligned} \tag{53.15}$$

From Eqs. (53.14) and (53.15), there will be three possible scenarios of stimulation to induce the second member to contribute knowledge. When $I < \phi/\lambda(1 + \lambda)$, obviously the second member does not want to contribute its knowledge. When $I > \phi/\lambda$, the second member will contribute its knowledge. When $\phi/\lambda(1 + \lambda) < I < \phi/\lambda$, it will not be sure that the second member contributes its knowledge. Figure 53.1 describes the possible scenarios whether the second member contributes its knowledge.

53.4.1 Region I

In this region, $I < \phi/\lambda(1 + \lambda)$ and $k_2 = 0$. Hereby, the incentive level is too low to induce the second member to contribute knowledge ($k_2 = 0$). According to formula (53.11) and (53.12) we can obtain:

$$s_1 = 1 - I \text{ and } s_2 = I$$

Take these values into formula (53.7):

$$\underset{I}{Maxmize}\ 1 - (1 - I)^2 \big/ 2 - I^2/2 - rI^2\sigma^2/2$$

The first order condition is:

$$I^1 = 1\big/2 + r\sigma^2 \tag{53.16a}$$

Using the formula (53.16a), (53.11) and (53.12) we can obtain directly the efforts of two members and the second member's compensation, the first member's expected revenue:

$$s_1^1 = 1\big/1 + 1\big/1 + r\sigma^2 \tag{53.16b}$$

$$s_2^1 = 1\big/2 + r\sigma^2 \tag{53.16c}$$

$$M^1 = -(3 + r\sigma^2)\big/2(2 + r\sigma^2)^2 \tag{53.16d}$$

$$Q^1 = 1 + r\sigma^2\big/2(2 + r\sigma^2)^2 \tag{53.16e}$$

$$H^1 = {3 + r\sigma^2}/{2(2 + r\sigma^2)} \tag{53.16f}$$

53.4.2 Region III

In this region, $I > \phi/\lambda$, $k_2 = 1$. Hereby, the level of stimulation is high enough to induce the second member to contribute its knowledge ($k_2 = 1$), According to formula (53.11) and (53.12), we can obtain:

$$s_1 = (1 - I)(1 + \lambda)_{和}\ s_2 = I(1 + \lambda)$$

Take these values into formula (53.7)

$$\underset{I}{Maxmize}\ (1+\lambda)^2 - (1-I)^2(1+\lambda)^2\Big/2 - I^2(1+\lambda)^2\Big/2 - rI^2\sigma^2/2$$

The first order condition is:

$$I^3 = {1}\Big/{2} + {r\sigma^2}\Big/{(1+\lambda)^2} \tag{53.17a}$$

Obviously, for any value λ was taken, it is certain that $I^3 > I^1$. This is not surprising, because in order to make $k_2 = 1$, you need a higher incentive level. From equation (53.11) (53.12) and (53.17a), you can directly gain the efforts of two members, the remuneration of the second member, and expected income of the first member:

$$s_1^3 = \left(\frac{(1+\lambda)^2 + r\sigma^2}{2(1+\lambda)^2 + r\sigma^2}\right)(1+\lambda) \tag{53.17b}$$

$$s_2^3 = \frac{(1+\lambda)^3}{2(1+\lambda)^2 + r\sigma^2} \tag{53.17c}$$

$$Q^3 = \frac{(1+\lambda)^4\left((1+\lambda)^2 + r\sigma^2\right)}{\left[2(1+\lambda)^2 + r\sigma^2\right]^2} + \phi \tag{53.17d}$$

$$H^3 = \frac{(1+\lambda)^2\left(3(1+\lambda)^2 + r\sigma^2\right)}{2\left[2(1+\lambda)^2 + r\sigma^2\right]^2} - \phi \tag{53.17e}$$

As long as $\lambda > 0$, based on comparison of members' contributions between in the regional Iand in the region III we could obtain:

① $s_1^3 > s_1^1$, the first member's effort in the region III is more than that in the region I.
② $s_2^3 > s_2^1$, the second member's effort in the region III is more than that in the region I.

We can get a conclusion hereafter (1): high level of stimulation in the region III not only can induce the second member to contribute k_2, but also cause the second member to make a higher level of effort (s_2), and so can the first member accordingly (s_1).

This consequence may be somewhat surprising, because of the higher s_2 and k_2 of the second member, for the first member, a free-riding motivation come into being. However, contrary to the Holmstrom (1994) conclusions of free-riding in a team production, our study show that the increase of the contribution of the second member at the same time, the first member will increase its own contribution too. Benefit directly from a high contribution of the second member, the first member would increase its marginal productivity itself.

In this case, because the first member has the residual claim, and thus encourage it to increase its own contribution, rather than to shirk its responsibility.

53.4.3 Region II

In this region, $\phi/\lambda(1+\lambda) < I < \phi/\lambda$, it is possible or not for the second member to contribute its knowledge ($k_2 = 0$ or $k_2 = 1$). From the angle of ϕ, this region may be also shown in Fig. 53.2 for three intervals.

We can conclude from Fig. 53.2, the separation of the intervals is very intuitive. When the second member's cost (k_2) of contribution knowledge is very high (i.e. ϕ is very high), the second member will not choose to share its knowledge. On the other hand, when the second member's cost (k_2) of contribution knowledge is very low, the second member will choose to share its knowledge. However, the situation of contribution knowledge in interval ii is not clear. Whether the first member encourages the second member to make contribution its knowledge in interval ii, depends on weather the revenue of the first member can be increased in the case of

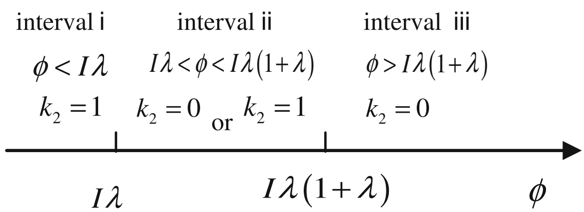

Fig. 53.2 Influence of contribution cost on knowledge sharing

contribution knowledge from the second member ($k_2 = 1$) rather than not ($k_2 = 0$). Then, in interval ii, the necessary condition of the first member's encouragement the second member to contribution knowledge can be expressed as:

$$H_{k_2=1} > H_{k_2=0} \tag{53.18}$$

From the previous derivation,

$$H^1 = H_{k_2=0} = {3 + r\sigma^2}/{2(2 + r\sigma^2)}$$

$$H^3 = H_{k_2=1} = \frac{(1+\lambda)^2\left(3(1+\lambda)^2 + r\sigma^2\right)}{2\left[2(1+\lambda)^2 + r\sigma^2\right]^2} - \phi$$

Therefore, the necessary condition of encouragement the second member to contribute knowledge in the interval ii may be obtained by the following calculation:

$$\begin{aligned} & H_{k_2=1} > H_{k_2=0} \\ & \Rightarrow \frac{(1+\lambda)^2\left(3(1+\lambda)^2 + r\sigma^2\right)}{2\left[2(1+\lambda)^2 + r\sigma^2\right]^2} - \phi > \frac{3 + r\sigma^2}{2(2 + r\sigma^2)} \\ & \Rightarrow \frac{(1+\lambda)^2\left(3(1+\lambda)^2 + r\sigma^2\right)}{2\left[2(1+\lambda)^2 + r\sigma^2\right]^2} - \phi > \frac{3 + r\sigma^2}{2(2 + r\sigma^2)} \\ & \Rightarrow \phi < \frac{6(1+\lambda)^2\left[(1+\lambda)^2 - 1\right] + 3r\sigma^2\left[(1+\lambda)^4 - 1\right] + (r\sigma^2)^2\left[(1+\lambda)^2 - 1\right]}{2(2 + r\sigma^2)\left[2(1+\lambda)^2 + r\sigma^2\right]} \end{aligned} \tag{53.19}$$

The conclusions (53.2) from the above: whether to motivate the second member to share its knowledge in the interval ii depends on the risk factors ($r\sigma^2$), the sensitivity (λ) of the influence of k_2 on the team output, as well as the cost (ϕ) of the second member to contribute its knowledge.

53.5 Conclusion

This paper studies the effectiveness of the dynamic mechanism of knowledge sharing in the research team. Studies have shown that:

1. There are three decision variables which are able to influence knowledge sharing among research team, they are risk factors, risk factors ($r\sigma^2$), the sensitivity (λ) of the influence on the team output, the cost (ϕ) of member 2 to

contribute its knowledge. When the second member's cost of contribution knowledge is relatively lower, the first member is easier to induce the second member to share its knowledge through the incentive mechanism. However, the first member's benefits from encouragement other members to share their knowledge, depends on the sensitivity of the impact of the knowledge-sharing team output. In addition, if the risk factor was very high, the first member should have to pay the second member a very high risk premium.

2. When the first member induces the second member to share its knowledge in use of incentive mechanism, the first member will increase its own investment in team production, which is different from the phenomenon of free-riding in team production.

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Chapter 54
Knowledge Structure Research on Achievement Transformation in Scientific and Technical Research Talented Person

Qi Suo

Abstract Achievement transformation in scientific and technical research talented person refers to knowledge-based talent who works in the process of scientific and technological achievements transformation. The process of transformation can be divided into scientific research, technological development, product process design and management. According to the three phases, this article divided talent into research and innovation talent, technology innovation talent, and markets innovative talent. Then the paper analyzed talent's knowledge composition from the breadth of structure and depth of structure.

Keywords Achievement transformation in scientific and technical research · Breadth of knowledge structure · Depth of knowledge structure · Talent

54.1 Introduction

The process of converting from achievement transformation in scientific and technical research (ATSTR) is a knowledge intensive area, which is the essence of knowledge flow. Thus accurately distinguishing knowledge flow can improve science and technology achievements conversion rate, industrialization rate, so is of important significance (Wu and Wang 2009). But science and technology do not create value. ATSTR talented person is the key carrier of science and technology. The job is advanced and complicated labor (Ghalib 2004). And they can make use of knowledge, technology, information, experience to resolve practical work and actual problem (Jantunen 2005).

Q. Suo (✉)
College of Economics and Management, Qingdao University of Science and Technology, Qingdao, China
e-mail: suoqi1980@163.com

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Domestic and foreign experts have done mass research on talent management and knowledge management. And theory, technology, practice literature are too numerous to enumerate. But most of the research on talent management and knowledge management is isolated, the study of integration of both is rarely seen. This article will put two researches together, from a knowledge point of view on knowledge composition of talented person.

54.2 Knowledge Structure

Knowledge structure is the state of knowledge, and the intrinsic relationship between the states (Huang 2006). Organization's knowledge structure is that people have the knowledge from organization's point, which is a personal extension of the knowledge structure. Organization knowledge is the collective body of knowledge, which is of a key factor in the knowledge conversion success rate (Malone 2002). ATSTR talented person in different stages has its own characteristics, and also requires different knowledge. Analysis of the different stages of talents' knowledge structure is conducive to the overall planning and organization of knowledge. It is the precondition of giving full play to the talents of knowledge, improve the talent planning effectiveness.

ATSTR is a complicated system engineering, can be divided into test stage, trial stage, the stage of mass production and the market development stage (Wang 2007), each step requires coordination, cooperate with each other to achieve a smooth transformation. The talent in whole transformation process is knowledge talent, which has the innovation ability, learning ability, have extensive knowledge, can use ability, cleverness and mastery of the knowledge innovation, and apply knowledge capital to create enormous wealth.

ATSTR talented person refers to those in the transformation of scientific research, technology development, product design process and management of the knowledge type talented person. The transformation process is the essence of knowledge flow, as the carrier of knowledge—ATSTR talented person whose knowledge structure has reflected higher value. Therefore the research will make accurate definition of professionals' knowledge structure from the process of the transformation of scientific achievements.

According to ATSTR in the three stages, the talent is divided into: R&D innovation talent, technology innovation talent, market innovation talent. Compared with the technological development, achievement of science and technology, the production of commodity need more support. Each stage of the talent's knowledge characteristic is not identical; the structure is as shown in Fig. 54.1.

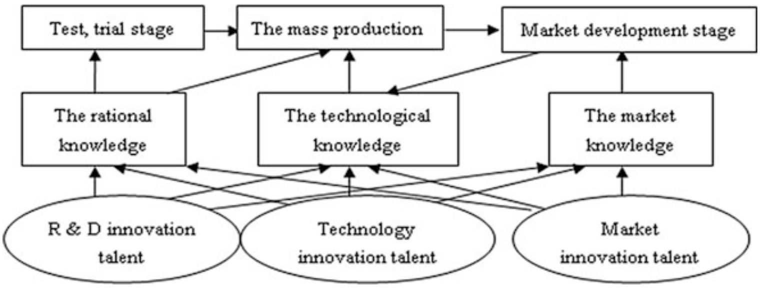

Fig. 54.1 Knowledge management and personnel management of coupling in three stages of scientific and technological achievements

54.3 Breadth of Knowledge Structure for ATSTR Talented Person

Firstly, we need to consider is the talent of the breadth of knowledge structure, mainly covering the fields of study. In the process of transformation, talents must master scientific and technological achievements of theory, technology, process, meanwhile master design, marketing strategy, consumer behavior and other basic knowledge. This knowledge can be divided into the rational knowledge, technological knowledge and market knowledge (Liu and Wan 2007).

- The rational knowledge is basic knowledge for technology innovation talent. This kind of knowledge guides the formation of scientific and technical achievements, describes the principle and technical level of scientific and technological achievements. The rational knowledge is divided into highly abstract theoretical knowledge and key technology derived by theory. The former is the basis of research results; the latter is often referred to the core technology, which is the key of knowledge protection.
- The technological knowledge is those that contribute to the product from the laboratory to the market. This kind of knowledge can ensure ATSTR, which is to say in the premise of marketing, to reduce costs, improve product competitiveness. Mainly it includes process knowledge, knowledge of equipment manufacturing technology, cost knowledge.
- Market knowledge refers to those have the ability of making products to meet consumers' demands, including product design, market preference, consumers pay ability, industry competitors.

The knowledge of ATSTR talented person should cover three aspects of knowledge in the conversion process in breadth. In the transformation of three stages, each stage is associated with various knowledge interaction, transformation, integration, innovation, but the transformation vectors—research and innovation talent, technology innovation talent, market innovation talent have different characteristic in the breadth of knowledge structure.

54.3.1 The Breadth of Knowledge Structure for R&D Innovation Talent

For R&D innovation talent, in the knowledge structure the core knowledge is profound theoretical knowledge, namely the rational knowledge. Through improving their own knowledge, R&D innovation talent can guarantee the advanced nature of technology, reliability, maturity. In addition to change from laboratory results to the prototype product, the technological knowledge is the guarantee of basis on production. To master this kind of knowledge can not only affect the product cost structure, but also can enhance the product manufacturability, accelerate new product development speed to market. If we want to transform science and technology to goods that will meet the needs of people, we must forecast the demands for goods (Schuller 2000). So the market knowledge is the premise of development. The important degree of three kind of knowledge for R&D innovation talent is the inverted pyramid structure, as shown in Fig. 54.2.

54.3.2 The Breadth of Knowledge Structure for Technology Innovation Talent for R&D Innovation Talent

For technology innovation talent, in the knowledge structure the core knowledge is technology knowledge. Because of technological process and technological complexity, technology innovation talent should have specialized knowledge, proficient operating skills in the batch stage of production. Their technology knowledge level directly affects the quality of products; this kind of talent is the main army transforming the achievements into goods. Market knowledge can guide the technology innovation talent to adjust product appearance, quantity; its importance is located in the middle of pyramid. In addition, technology innovation

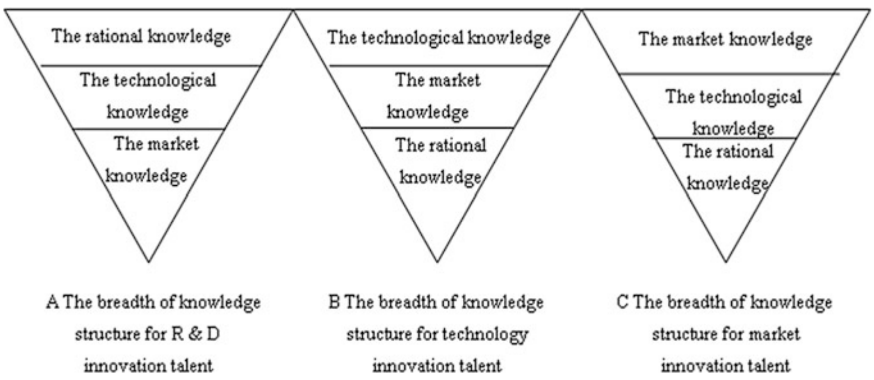

Fig. 54.2 The breadth of knowledge structure for ATSTR talented person in different stages

talents must understand the rational knowledge, but does not require in-depth understanding. The important degree of three kind of knowledge for technology innovation talent is the inverted pyramid structure, as shown in Fig. 54.2.

54.3.3 The Breadth of Knowledge Structure for Technology Innovation Talent for Market Innovation Talent

For market innovation talent, in the knowledge structure the core knowledge is market knowledge. Understanding consumer preference, accurate positioning of target market, can achieve scientific and technological achievements of rapid commercialization, industrialization. In addition to the market promotion, market innovation personnel need to have simple process of product structure, rational knowledge in order to promoting. The important degree of three kind of knowledge for market innovation talent is the inverted pyramid structure, as shown in Fig. 54.2.

Completing the goal for transformation of scientific and technological achievements, is the minimum requirements for ATSTR talented person in the breadth of knowledge structure, is a static view of knowledge. In the dynamic view it is also due to the generation and gain of new knowledge. The intense market competition and the rapid development of science and technology requirements of personnel continually expanding the breadth of knowledge, and improve the innovation ability of enterprise. Breadth of knowledge expansion must unfold around key knowledge domain. On the innovation of talent management, we will have a different discipline backgrounds professional together, forming a diverse knowledge communities around the key knowledge domain.

54.4 Depth of Knowledge Structure for ATSTR Talented Person

Depth of knowledge structure for ATSTR talented person refers to the different people's knowledge in the depth dimension. For each kind of knowledge, different science and technology requires different depth based on diverse requirements (Li et al. 2010; Park and Kim 2005). Similarly, in different stages in ATSTR, for all kinds of personnel knowledge depth requirements are different. The breadth of knowledge structure for successful transformation provides a "face" on the deployment, and the depth of knowledge structure is transforming the "face" into the "body", leading to the formation of people's knowledge space. The structure provides a knowledge platform for personnel to make effective allocation and development. ATSTR talented person in the depth of knowledge structure is divided into three types:

- Executive for problems. This kind of talent can master knowledge and apply them to practice. But their usage of knowledge performs for the standardization, stylized process. The application of knowledge capacity is limited to the level of "how to do", lack of flexibility and initiative.
- Solver for problems. This is in higher knowledge level than the former. These people not only can use knowledge to complete the work, but also are able to apply knowledge to analyze and solve new problems, can skilled found the crux of the problem and remedy them.
- Talent for system reconstructing. This kind of talent is the most precious resources, they can not only analyze and solve problems, but also as the breakthrough point, through the problems to see the essence, found in-depth problems. And they can apply knowledge to design and construct the whole system, thus generating new knowledge. According to analysis of scarcity, the three types of talent appear pyramid structure distribution taking concerns of number, as shown in Fig. 54.3.

According to three different stages and the demand for knowledge, the paper thinks that R&D innovation talent, technology innovation talent, market innovation talent have different requirements in the depth of knowledge structure.

54.4.1 The Depth of Knowledge Structure for R&D Innovation Talent

Laboratory, pilot stage is the initial stage of ATSTR, the depth of knowledge structure for R&D innovation talent determines its ultimate the effectiveness of marketization, industrialization and long-term implementation. So the depth of knowledge demand is higher, the structure should be inverted pyramid structure. The kind of talents for system reconstructing in quantity should be mostly, can do

Fig. 54.3 The breadth of knowledge structure for ATSTR talented person in different stages

research and development from the initial technical innovation. While executive for problems can only use simple knowledge, should occupy less proportion in R&D innovation talent. The depth of knowledge structure is shown in Fig. 54.4.

54.4.2 The Depth of Knowledge Structure for Technology Innovation Talent

Technology innovation talent plays a central role in the transformation process, performing the sample into the batch production of products work. This job requires not only simple usage of knowledge, experience, but also analysis of processing problems in production. So the depth of knowledge structure for technology innovation talent is spindle structure, namely "both ends is small, among big" structure, which is shown in Fig. 54.4.

54.4.3 The Depth of Knowledge Structure for Market Innovation Talent

Market innovation talent achieves the transformation of the final link, will meet the need of the people in the process of commodity market. The depth of knowledge is not high, just master certain product, market, consumer knowledge, and apply to practical promotion process. The depth of knowledge structure of talents should be inverted Pyramid structure, shown in Fig. 54.4.

For different stages in ATSTR will require different knowledge, analysis of the knowledge structure is the precondition of making full use of knowledge, improving enterprise talent planning validity and pertinence.

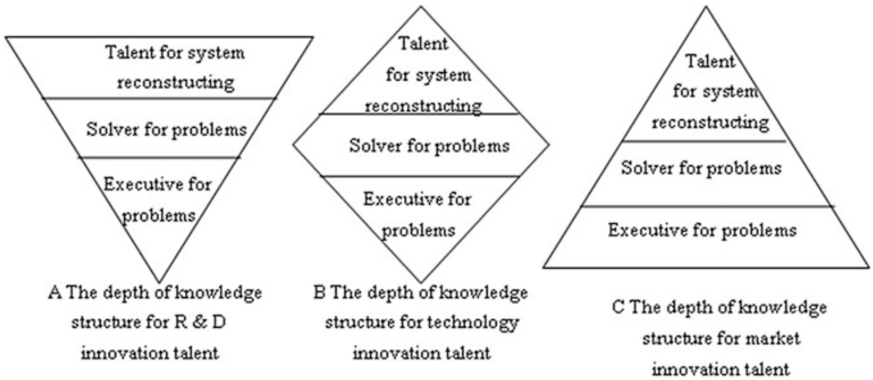

Fig. 54.4 The depth of knowledge structure for ATSTR talented person in different stages

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Chapter 55
An Analysis of Employee Turnover Based on Behavioral Economics

Ke-da Gao

Abstract With the deepening of China's social and economic transformation, companies are faced with an increasingly common phenomenon of employee turnover, which seriously impedes the development of companies. Based on the "irrational person" perspective of behavioral economics, this article analyzes the problem of employee turnover from Prospect theory, Anchoring effect and Mental account theory which are different from those of traditional economics, and illustrates how irrational factors affect employees to make a decision to quit, therefore companies can have a more realistic and reasonable understanding of the phenomenon of employee turnover.

Keywords Behavioral economics · Irrationality · Employee turnover

55.1 Backgrounds and Significance

Employee turnover is an important issue that enterprise managers must pay attention to, especially, the quit of those key employees would have an impact on normal operation of the enterprise, and even hinder the development of the enterprise. The loss of many employees always makes the managers feel confused because a lot of employee turnover in real situations are often "irrational" behaviors. Therefore, enterprises should have a reasonable and comprehensive understanding of employee turnover. According to the Mercer Management Consulting in 2011 for 17 markets worldwide survey of more than 30,000 employees (including the 2,000 employees in mainland China), Chinese staff loyalty to the enterprise investigation significantly weakened when compared to

K. Gao (✉)
Zhejiang Gongshang University, Hangzhou, China
e-mail: Gaokeda.0602@yahoo.com.cn

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5 years ago, turnover rate has been rising in geometric level. Over one-third people are seriously considering leaving, 70 % of people whose ages are between 24 and 29 have considered leaving, top talents have started looking around for suitable new position.

With the economy and the employment situation continues to improve, companies are facing the risk of losing core workers at any time, which brings a big challenge to enterprise human resource management. This article analyzes employee turnover behavior from the perspective of behavioral economics, from the perspective of non-rational to interpret the turnover phenomenon, so as to help managers understand employee turnover with more realistic and reasonable perspective.

55.2 The Rationality of Employees' Behavior Analysis from Perspective of Behavioral Economics

Traditional economic theory suggests that people are rational and self-interested, seeking to maximize their interests in the labor market. However, that's not always the case in reality, the voluntary leaving of many employees are not rational decisions, because when people make decisions, it's easy to be influenced by those irrelevant factors such as environment, emotion, family and other people's behaviors, their work preferences would also change.

Theoretical analysis of mainstream economics is based on the premise of rationality which cannot effectively explain people's behaviors, its analysis does not take into account non-rational decision-making while behavioral economics is primarily to non-rational decision-making under uncertainty conditions for the study, behavioral economics does not negate rational behavior, but it is to prove the existence of irrational behavior (He 2004).

At the core of behavioral economics is the conviction that increasing the realism of the psychological underpinnings of economic analysis will improve economics on its own terms–generating theoretical insights, making better predictions of field phenomena, suggesting better policy (Camerer and Loewenstein 2003). In behavioral economics view, people's decisions made in their daily life are usually irrational. Because rational decisions require people accurately get all the information they need, but that is not the case, people in reality have no precise and comprehensive information, nor can they accurately predict the results. Whereas physiology viewed the body as a machine, psychology translated this into a perspective on the mind as a machine (Sent 2004). Behavioral economics combines analysis of people's economic behaviors primarily with psychological theory, it combines psychology and economics, providing more reasonable and realistic interpretation to those problems that conventional economics can't explain.

The study of workers' irrational decision-making helps companies better understand their departure which encourages companies to focus more on their workers' psychological, emotional, as well as other aspects of the situation, because usually the employees perform differently with the result of economics analysis, their actual behavior in traditional economics seems to be irrational, for it is not the pursuit of maximum personal interest. Only four determinants significantly influence both satisfaction and commitment: routinization, peer support, supervisor support, and workload (Currivan 2000). These irrationalities exist in our life, recognize them and the employees' behaviors can help companies know their employees better, thus better able to carry out staff management policies, find effective ways to solve the problem.

55.3 Behavioral Economics Explanation to Employee Turnover

Behavioral economics analysis of employee turnover is based on people's irrational behaviors caused by the deviation in recognition of the employment market as well as themselves when they are faced with the risk of re-employment decision-making. This article analyzes the problem of employee turnover from three basic theories in behavioral economics, that is Prospect Theory, Anchoring Effect and Mental Account Theory.

55.3.1 Employee Turnover Analysis Based on the Prospect Theory

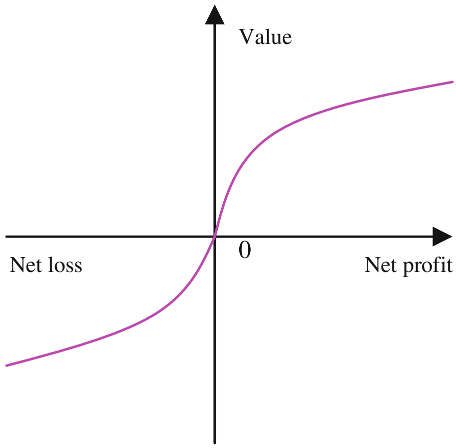
The Prospect Theory is advanced by Kahneman and Tversky, which says that people make judgments and decisions in uncertain conditions are irrational. The theory contains four basic views, (a) certainty effect, i.e., people are more willing to receive the existing determined benefits rather than taking a risk to get a bigger profit; (b) reflection effect, i.e., when the loss is certain, people are more willing to take a risk; (c) loss aversion, i.e., decrement in benefit of loss is greater than the increment in benefit of profit; (d) reference dependent, i.e., utility of income is relative, depending on the level of reference points.

The Prospect Theory can explain many of the turnover to some extent, when employees feel that their value are diminishing at the original post, in other words, people gradually deviate from the post value of human resource value, when employees are in a state of loss, even if the external market is uncertain, which cannot ensure that you get a better job, they are willing to "a gamble", to take risks because they expect the market to provide a better job. Despite the uncertainty of the employment market, moreover, new positions may be worse than the original, employees tend to leave to look for better job, which is caused by the reflection effect.

In addition, prospect theory can also explain employee turnover in terms of compensation. Different from traditional economics analysis of value and benefit of compensation, prospect theory analyzes people's cognitive law of compensation from the perspective of behavioral economics, also proposes value function and weight function. Compared with expected utility theory in conventional economics, value function replaces the utility function while weight values replace the expectations (Long et al. 2010). Value function (as shown in Fig. 55.1) describes people's value judgments on economic activity in risk decision-making, showing that people are always irrational when evaluating the value of pay and benefits.

The core idea of prospect theory—that the value function is kinked at the reference point and loss averse—became useful to economics when Thaler used it to explain riskless choices (Kahneman 2003). From the value function, we can see that people's evaluation of compensation depends on the reference point, moreover, compared to profit, people are more sensitive to loss. This can explain why the same income does not produce the same effect, which cannot be interpreted by traditional economics. Increase in compensation does not necessarily leads to increased benefit, and in comparable cases, the increased benefit brought by added absolute value of compensation is usually lower than the increased psychological effect arising from relative advantages. Preference theory of traditional economic suggests that utility is independent of the reference points, a certain level of income can always produce a certain level of effectiveness, increased income will lead to increased effectiveness. It is confirmed by behavioral economics that people's effectiveness depends not only on the absolute value of their own income, but are also influenced by other people's income. Many people quit their jobs because of the recognition deviation of compensation value, or the effectiveness doesn't meet their expectations in comparison with the reference point. Therefore, in this case, when enterprises try to retain key employees, it's better to raise

Fig. 55.1 Value function



comparable wages rather than increasing welfare which cannot be compared, compensation could and should be given in the form of diversification with treatment that other companies can't provide, it's far more effective than merely raise wages, and this is the perspective of behavioral economics.

55.3.2 Employee Turnover Analysis Based on the Anchoring Effect Theory

Anchoring effect means when people need to do a quantitative assessment, certain specific values will be used as the initial value, just like anchor restricts the estimates. When making decisions, they will unconsciously set the initial information as part of the evaluation criteria. Kahneman and Tversky pointed out that people often pay too much attention to the initial significant information when making judgment and have cognitive bias.

Traditional economics theory regards employee turnover as rational decisions which won't be interfered by unrelated factors, and people and always do proper analysis with correct information which is a rational cost-benefit analysis. If the current position cannot meet his own human resource value, he will choose to leave to find a new position on the job market that meets or even exceeds the value of his human resource value. In other words, if the employee's value matches the position value, they would stay. However, the reality is not that simple, a worker's decision to leave is not only dependent on cost-benefit analysis, but also under the influence of many other factors.

Anchoring effect is a kind of cognitive biases, which can also explain the irrational resignation. Behavioral economics suggests that people's preference is not stable, different preferences can be induced by different heuristics. When people make decisions, they tend to be subject to a prior "Association", which makes the final preference of selection bias and reverse (Dong 2005). In fact, people often make decisions under the influence of outside interference information and their own cognitive biases. External information such as environment, family, social relationships and so on will to a large extent, influence people's decisions, when these factors change, people would have a re-cognition and evaluation of the current position as well as its value. On the other hand, a worker's self-recognition can also be influenced by other irrelevant information, other people's words and actions can influence his decisions to a large extent. In this case, people leave their job mainly because of the external information and their own cognitive bias, not out of a rational analysis result.

55.3.3 Employee Turnover Analysis Based on the Mental Account Theory

In 1980, financial and behavioral economist Richard Thaler advanced the concept of mental account firstly, he said that there is a mental account when people making decisions, they would follow some potential rules of operation, which are different to those of traditional economics, these rules differ from traditional economics significantly regardless of accounting ways and behavior decisions, thus impact individual decisions unexpectedly, making individual decisions contrary to the simple laws of rational economic (Thaler 1985). In 1984, Kahneman confirm further that mental account is a process in which people do the classification, coding, valuation and budgetary psychologically, it reveals the cognitive process of wealth decision-making (Kahneman and Tversky 1984).

Wages in labor markets do not always clear the market: in many cases, firms pay a higher than market-clearing wage, resulting in involuntary unemployment (Gneezy and List 2006). Mental account theory can to a large extent explain the irrational behavior of employee turnover. Employee loyalty to the enterprise depends to a large extent on their psychological contract. Psychological contract will change with changes in the external environment and their self-cognition; it is subject to anchoring effect. Job avoidance represents an early phase of organizational withdrawal rather than substitutes for exits, as traditional thinking presumes. Job avoidance facilitates rather than dissipates the exit-inducing effects of poor attitudes. Organizations should thus regard excessive absences or tardiness as signs of impending resignations (Hom and Kinicki 2001). When a worker's psychological contract to his company can't continue, he would have a turnover intention which leads to resignation.

Mental account influence people's attitudes and behaviors by psychological contract, once the violation to his psychological contract accumulates to the limit of his mental account, his organizational commitment will decline and ultimately leads to resignation (Yuan and Yao 2010). The violation of psychological contract is shown in two aspects, namely economic account and emotional account. When an employee's wages, bonuses, benefits, and other economic benefits changes, his economic accounts will make an appropriate adjustment; also, if the economic benefits falls, economic accounts will be reduced, while psychological contract will also be destroyed, resulting in turnover. Emotional account mainly records the emotional interaction between employees and companies, when a company fails to meet the employees' emotional needs, such as paying no attention to their contribution, not giving reward, lack of learning and growing environment as well as supportive working conditions, it would damage the emotional account and psychological contract, thus force the employees to resign.

Therefore, from the perspective of mental account, a company should consider the effect of mental account when designing compensation and the form it is given, different forms bring about different feelings, and these feelings would be recorded in the mental account (Li and Ling 2009). When design the payment of compensation and rewards, companies should take into account the workers' expectations, adjust their reference point, and reduce the negative effect caused by the comparison to reference point. The most effective organizational responses to employee propensity to quit are those that combine multiple elements, including family-supportive benefits, human resource incentives, and work design (Batt and Valcour 2003).

In addition, studies have found that mental account plays an important role in the incentive because of emotional experiences in the process of value judgments (Wang and Bai 2009). The workers' effectiveness of compensation depends more on value judgment in mental account than other factors, and that can't be explained by traditional economics. As a result, behavioral economics based on the assumption of irrational people can analyze employees' effectiveness perception of compensation more realistically, and proposed a more reasonable explanation to turnover caused by dissatisfaction with pay.

55.4 Summary

This article explains the employee turnover from the perspective of behavioral economics based on "irrational people", different from traditional economics, behavioral economics studies people's behaviors in reality combined with psychology theory. Because in the job market, people would make irrational decisions due to cognitive bias of external information and themselves, therefore their resignation is somehow not a rational decision. According to the Prospect Theory, people will be differentiated based on the state of win or loss, and be influenced by the preference point. According to the Anchoring Theory, people tend to be anchored by outside external information, which leads to cognitive bias about their human resource value and post value. According to the Mental Account Theory, people would put all the negative information coming from current position to different mental account, the damage in mental account leads to damage in psychological contract, and ultimately give rise to turnover. Based on the assumption of irrational people, it is more realistic and reasonable to explain the employee turnover from the perspective of behavioral economics.

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Chapter 56
Empirical Research on the Influence Factors of Knowledge Absorptive Capacity of High-Tech SME

Mei-ying Yang, Yu-ning Zheng and Li-wen Peng

Abstract Based on summarizing and researching the existing literature of absorptive capacity, the author examines the relationship between the five factors (the individual knowledge base, the internal knowledge-sharing environment, the R&D status, the external knowledge exchange condition and the incentive policy) and the level of the absorptive capacity using an empirical research study approach of Beijing high-tech SMEs, and suggests that all these five aspects have significant impact on the level of absorptive capacity.

Keywords High-tech SME · Incentive policy · Knowledge absorptive capacity · Knowledge base · Knowledge exchange · Knowledge-sharing environment

56.1 Introduction

The technology level and the technological innovation capability is the fundamental cause to determine a country's progress and the economic growth. At the same time, the technological innovation capability largely reflects the country's technology level.

In 2011, the percentage of projects that enterprise have taken part in winning Reward of National Science and Technology Progress has raised from 69 to 72 %, in which SMEs accounted for 61.54 % (Sun 2012), that indicates that the SME is

M. Yang
School of Economics and Management, Beihang University,
Beijing, People's Republic of China

Y. Zheng (✉) · L. Peng
Department of Industrial Engineering, Different University of Hobbiton,
Hobbiton, New Zealand
e-mail: zyn3399@sina.com

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becoming an important force in China to accelerate scientific and technological achievements and technological innovation.

High tech small and medium-sized enterprise is the small and medium size enterprise that engaged in researching, developing, producing and providing service of high-tech products.

Technological innovation is undoubtedly the core competitiveness for SMEs, and it is the process of acquiring, assimilating, spreading and utilizing new knowledge. In this process, the enterprise's knowledge absorptive capacity largely reflects and restricts the level of technological innovation capabilities. China's SMEs have some advantages such as low initial investment costs, quick productive operation, however their overall technological innovation situation is not satisfactory. China's overall technical level is not high and the current innovation system and operating system is not quite reasonable is part of the reason. Besides, there are some other important factors that affect the innovation potential of enterprises that can be improved by enterprises, and the knowledge absorptive capacity is such an important factor.

Much of the previous studies have found that the knowledge absorptive capacity have a significant impact on technological innovation capability of enterprises. Therefore, the paper analyzes the main factors that affect knowledge absorption capacity based on the characteristics of the SME, and focus on the knowledge absorption capacity of individual then discuss the whole enterprise's knowledge absorption capacity. It will have some practical significance on how to strengthen the core competitiveness of China's high-tech SMEs.

56.2 Literature Review and Research Hypotheses

56.2.1 Literature Review

Foreign studies about the factors that influence absorptive capacity have a wider coverage and origin earlier. Firstly it's the impact that the individual capacity has on organization's knowledge capacity. Cohen and Levinthal (1990) had raised that the organization's absorptive capacity depends on members' absorptive capacity of the organization, and they analysis individual as the "gatekeeper" role to study their ability to identify and transfer ability of knowledge. Knockaert et al. (2011) had also researched the individual's external function for the organization, for example the staffs observe the external environment of the enterprise in order to evaluate the knowledge outside to meet the company's needs.

Jones and Craven (2001) focused on the ability of the managers to expand the existing knowledge (Oswald and Martin 2001). Another category is to research the impact of the enterprise knowledge base for knowledge absorption capacity. Cohen and Levinthal (1989) had researched the importance of accumulated knowledge for knowledge absorption capacity. Kim (1998) and Gann (2001) were concerned about the impact of the existing level of technology. Another category can be described as enterprises effort factor including researches that use the level of R&D expenditures as study object. And George et al. (2001) analysis knowledge absorption capacity represented by corporate patents; Jones and Graven raised that absorption capacity can be represented by labor productivity. In addition, another important factor is enterprise organizational structure. Van Den Bosch et al. (1999) emphasized the organization form as object. And Tsai (2001) paid more attention to the characteristics of the coalition.

Foreign scholars studied the knowledge absorptive capacity more in-depth, but the overall framework is of loose.

Chinese scholars' study of knowledge absorptive capacity influencing factors mostly learned from foreign literature. Zhang researched the relationship between knowledge absorptive capacity and organization performance empirically. When discussed the influencing factors, he proposed that staff capacity is positive correlated with knowledge acquisition, information distribution and information interpretation, staff motivation is positive correlated with information distribution and organizational memory (Zhang 2011). Liu and Xie (2003) generalized four factors: priori knowledge, R&D intensity, learning strength and methods, organizational learning mechanisms. Ning and Wu (2007) abstracted six influencing factors: R&D input, priori knowledge, learning strength, organizational structure, human capital and corporate culture. Wu put forward five factors as degree of interaction, level of effort, degree of contact, trust factors and support factors (Wu et al. 2007).

From the reviews of literatures, the research studied the organizational factors' impact on knowledge absorptive capacity from different perspectives. Some paid attention to the individual ability, but in their researches the individual factor is not the center of attention.

56.2.2 Research Hypotheses

This paper will set the individual employee as research center and start from the individual knowledge base then analysis the impact of enterprise internal and external knowledge environment, the corporate R & D management level, and to explore the influencing factors of knowledge absorption capacity of SMEs.

The enterprise absorptive capacity depends on the individual absorptive capacity and individual absorptive capacity includes internal function and external function. The external function is that individual staff values the correlated knowledge outside. In this process, the expertise of individual members is an important factor because the higher degree of similarity individual having with external knowledge, the easier it is to absorb external knowledge. The staff transfers new knowledge to other staff is internal function that reflects the transfer efficiency of enterprise. In this function, the similarity of different staffs' knowledge base is more important. Thus, we select the degree of knowledge overlap, the academic qualification level and the necessary skills level of the enterprise employees to measure the individual knowledge absorptive capacity.

If the enterprise internal sharing environment is different, for example the leaders implement different cultures to promote or inhibit knowledge dissemination, the enterprise will perform different knowledge behavior. Therefore, we investigate the situation about knowledge absorbing and transfer as the attitude of the senior leadership on dissemination of knowledge and the internal culture of knowledge dissemination and so on.

The R&D activities are to increase the overall knowledge and to explore their new applications. Through the R&D activity, the enterprise can enhance the flow and transformation of tacit knowledge and improve the structure of the stock knowledge (Gurneeta 2011). So this paper will investigate the R&D investment status and leader's attitude towards R&D.

The external communication can create and strengthen the channels of knowledge exchange thus enhance the density and intensity of knowledge flow and facilitate information sharing (Xiong 2011). This paper consider the external communication subjects such as customers, suppliers, research institutions, universities, government departments and research the external communication from scope and frequency aspects.

Enterprise's incentive policies for employees' knowledge absorptive capacity reflect the initiative of mobilizing employees. The enthusiasm level of staff no doubt will affect the enterprise knowledge absorptive capacity. We mainly consider the impact of internal promotion and salary incentive on staffs' enthusiasm.

According to the analysis above, we make the following research hypotheses:

H1 Individual knowledge base has positive impacts on the enterprise's knowledge absorptive capacity.

H2 Enterprise's internal knowledge-sharing environment has positive impacts on its knowledge absorptive capacity.

H3 Enterprise's R & D status has positive impacts on its knowledge absorptive capacity.

H4 Enterprise's external knowledge exchange has positive impacts on its knowledge absorptive capacity.

H5 Enterprise's incentive policies have positive impacts on its knowledge absorptive capacity.

56.3 Research Design and Questionnaire Survey

According to the individual-based enterprise knowledge absorptive capacity model in this paper, we design the questionnaire to measure both of the influencing factors of high-tech SMEs knowledge absorption capacity and the enterprise knowledge absorption capacity. The questionnaire strives to design around the research questions and assumptions and give full consideration to the respondents of different background.

The questionnaire is composed of three parts. The first part is about the basic information of respondents and their companies ensuring the effectiveness of the completed questionnaires. The second part is the instigation of influencing factors that consists 5 dimensions constant with the 5 hypotheses proposed previously. The items are designed based on the theoretical analysis before. The third part is items to measure knowledge absorption capacity from identifying external new knowledge, digesting and absorbing knowledge and making use of knowledge. The items of last two parts are based on a five point Likert scale.

56.3.1 Questionnaire Survey

The questionnaires were filled in by middle or senior managers in R&D division of high tech SMEs in Beijing. In total, 205 questionnaires from 243 were returned (a 84.4 % response rate) and 181 effective questionnaires (a 74.5 % effective response rate).

56.3.2 Reliability Test

Cronbach's α coefficient is adopted to validate the scale's reliability. It ranges between 0 and 1 and α greater value represents a higher confidence level. In accordance with the standards of experts, this study using Cronbach's α value is greater than or equal to 0.7 for the criteria.

Using spss to analysis the 5 influencing factors and the result shows that other four factors' Cronbach's α are 0.851, 0.851, 0.653 and 0.773 higher than standard 0.7 except factor individual knowledge base. And after remove the no. 1 item in the first factor, its Cronbach's α is over 0.7. Therefore, the variables are set reasonable and the scales have high reliability and internal consistency after the revision. For the analysis of enterprise knowledge absorption capacity, its Cronbach's α is 0.92 higher than the standard 0.7.

56.3.3 Validity Test

This study sets KMO value greater than or equal to 0.6 for the criteria and set significant probability of Bartley sphere inspection lower than 0.001 for refusing the null hypothesis of the correlation coefficient matrix is a unit matrix. The results showed that the KMO data of influencing factors scale is $0.861 > 0.6$ and significant probability of Bartley sphere inspection of the scale is $0.000 < 0.001$. The second scale KMO data is $0.912 > 0.6$ and significant probability of Bartley sphere inspection is $0.000 < 0.0\ 01$. This indicates the data from the scales are fit for the factor analysis.

The principal component analysis results indicate that after varimax the common factors extracted from influencing factors scale and absorptive capacity scale are all consistent with the dimensions designed in the paper and the cumulative variance contribution rate are 70.29 and 61.17 % respectively. Besides the factor loads of each item are higher than 0.6. In a word, the scales reached the criteria of good construct validity.

56.4 Date Analysis

56.4.1 Correlation Analysis of Enterprise Influencing Factors of Knowledge Absorptive Capacity and Enterprise Knowledge Absorptive Capacity

We select Kendall's tau_b to conduct the bilateral significance test. The result of correlation analysis between influencing factors and knowledge absorptive capacity are shown in Table 56.1. We can see that the kendall's tau_b of individual knowledge base, internal sharing environment, R&D status, external communication and the incentive policy are significant in the specified level. That means the individual knowledge base such as the degree of knowledge overlap and the necessary skills level of the enterprise employees have a significantly positive relationship with enterprise knowledge absorptive capacity; the internal sharing situation such as the attitude of senior leadership on dissemination of knowledge will affect the knowledge absorbing and transfer; the R&D investment status and leader's attitude towards R&D also can largely influence the knowledge absorption and application; the external communication scope and frequency have a positive effect on enterprise knowledge absorptive capacity; the use of internal promotion and salary incentive policy can facilitate absorptive capacity is supported too.

56.4.2 Regression Analysis of Enterprise Influencing Factors of Knowledge Absorptive Capacity and Enterprise Knowledge Absorptive Capacity

We use regression analysis to test and verify the specific relationship between dependent variable and independent variables. And use mathematical models to perform their specific relationship. The model summary results are shown in Table 56.2, analysis of variance results are shown in Table 56.3 and coefficients and significance test results are shown in Table 56.4.

Table 56.1 Correlation analysis

Individual knowledge base		Knowledge base	Absorptive capacity
	Correlation Coefficient	1	0.193**
	Sig. (2-tailed)	.	0
Internal sharing environment		Sharing environment	Absorptive capacity
	Correlation Coefficient	1	0.483**
	Sig. (2-tailed)	.	0
R&D status		R&D status	Absorptive capacity
	Correlation Coefficient	1	0.404**
	Sig. (2-tailed)	.	0
External communication		External communication	Absorptive capacity
	Correlation Coefficient	1	0.293**
	Sig. (2-tailed)	.	0
Incentive policy		Incentive policy	Absorptive capacity
	Correlation Coefficient	1	0.376**
	Sig. (2-tailed)	.	0

[a] Significant correlation at 0.01 confidence level (2-tailed)

Table 56.2 Model summary results

Model summary

Model	R	R Square	Adjusted R square	Std. error of the estimate
1	0.712	0.507	0.493	0.466

Table 56.3 Results of variance analysis

ANOVA

Model		Sum of squares	df	Mean square	F	Sig.
1	Regression	39.249	5	7.850	45.008	0.000
	Residual	38.183	176	0.217		
	Total	77.432	181			

Table 56.4 Results of coefficients and significance test

Coefficients

Model	Unstandardized coefficients		t	Sig.	Collinearity statistics	
	B	Beta			Tolerance	VIF
(Constant)	0.389		2.443	0.016		
Individual knowledge base	0.185	0.155	3.125	0.011	0.778	1.553
Internal sharing environment	0.413	0.392	6.097	0	0.677	1.477
R&D status	0.196	0.23	3.624	0	0.694	1.442
External communication	0.127	0.143	2.446	0.015	0.818	1.223
Incentive policy	0.128	0.163	2.53	0.012	0.675	1.482

We can see from Table 56.2 that the regression equation can explain 50.7 % of the total variance. Table 56.3 shows F = 45.008, P = 0.000 so indicators have reached a significant level and can be seen that the regression is good. In Table 56.4, constant and five influencing factors' Sig. values are all less than 0.05 thus they are significant. Besides, their VIF are all less than 10 and each variance's tolerance is more than 0.5 so there is no multicollinearity problem. Consider the absolute value of regression coefficient, the internal sharing environment factor has the biggest impact on enterprise knowledge absorptive capacity (standardized regression coefficients is 0.392).

In this paper, we found H1, H2, H3, H4 and H5 are all supported by the data.

56.5 Conclusion

1. *Employees' knowledge base significantly affected the enterprise knowledge absorption capacity.* Therefore, enterprise can enhance training so to promote the level of staff knowledge and skills and strengthen the knowledge base.
2. *Internal knowledge sharing environment have a positive effect on enterprise knowledge absorption capacity.* Enterprise can pay attention to strengthen the interaction between the internal staff to promote the flow of knowledge within the enterprise, for example facilitating the communication of staff in an informal setting to promote cooperation between different departments. We found this factor has the biggest impact on enterprise knowledge absorptive capacity, so if high_tech SMEs improve this factor first, the improvement efficiency of knowledge absorptive capacity will be higher.
3. *Technology R&D has a direct impact to enhance absorptive capacity.* It requires enterprise to focus on investment in R&D to ensure the efficiency of production of knowledge.
4. *The external communication has a significantly positive relationship with enterprise knowledge absorption capacity.* Thus, the enterprise should strengthen the links with various research institutions. This can helps to

enhance the complementary knowledge and contribute to absorbing the external knowledge.

5. *The incentive policy significantly affected the enterprise knowledge absorption capacity.* Therefore, enterprises should set up appropriate mechanisms to encourage employees to obtain and utilize advanced knowledge.

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Chapter 57
Enterprises' Social Capital and the Economic Performance of Local Government Funded Science and Technology Projects: An Empirical Research

Tian-qi Li, Guo-qing Huo and Xiao-dong Zhang

Abstract In the process of the implementation of government funded science and technology projects, enterprises can accumulate a certain amount of social capital through establishing social relationships with governments, universities, science and technology organizations, and banks. This paper firstly determined social capital and economic performance of local government funded science and technology projects factors and criteria weights in conjunction with professional opinions and the analytical hierarchy process. Then based on the analysis of 40 science and technology projects financially supported by Karamay, we set up a multiple linear regression model to test the assumptions of the correlation between the economic performance of projects and enterprises' social capital accumulated in the process of implementing science and technology projects. Results indicate that there is a notably positive correlation between social capital and project economic performance.

Keywords Analytic hierarchy process (AHP) · Economic performance of projects · Empirical research · Government funded science and technology projects · Social capital

T. Li (✉) · X. Zhang
Management School, Graduate University of Chinese Academy of Sciences, Beijing, China
e-mail: ltqapple@163.com

G. Huo
College of Technology Management, Graduate University of Chinese Academy of Sciences, Beijing, China

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57.1 Introduction

With the advent of knowledge-based economy and the new situation of vigorously promoting independent innovation capability, the role of science and technology (S&T) has become increasingly prominent, so recently the methods of relying on technological progress to promote economic growth have become the focus of regional competitions (Zhang and Tian 2010). Investment in S&T is necessary for S&T progress, and the quantity determines the scale of S&T activities, so local governments constantly increase investments in S&T. The investments of local government in S&T mainly focus on enterprises' S&T projects, including basic research projects, applied research projects and experimental development projects.

During the implementation of government funded S&T projects, enterprises acquire valuable social resources through the cooperation with universities, S&T organizations, and government departments, with the result of higher social credibility. So how can the social capital that the enterprise accumulates through implementing the government funded project impact on the final project performance? In this paper we first founded the index system for social capital and economic performance of government funded S&T projects in conjunction with professional opinions and the analytical hierarchy process (AHP), and then based on the analysis of 40 S&T projects financially supported by Karamay (a city in Xinjiang Province), we set up a multiple linear regression (MLR) model to examine the correlation between the economic performance of S&T projects and enterprises' social capital accumulated in the process of implementing S&T projects.

57.2 Literature Review and Hypothesis

57.2.1 Definition of Social Capital

Social capital was first proposed by a French sociologist named Pierre Bourdieu in 1980, who defined social capital as the third form of capital coordinated with economic capital and cultural capital, and a realistic or potential resource collection which could not be separated from some persistent network possessions. Subsequently, scholars developed intensive studies on social capital; however, at present there is no unified understanding. Nahapiet and Ghoshal (1998) defined social capital as the sum of actual resources and potential resources embedded in the personal or social groups in the network of relationships, which could be utilized. Alder and Kwon (2002) regarded social capital as the resource for members in the network, which could be obtained in accordance with their positions in the structure of social relations. Zhu and Cai (2007) claimed that social capital was the sum of social network relations referring to clusters of enterprises or institutions, and businesses could achieve benefits by using this network relationships. Haixiong (2000) considered social capital was a social network formed on the basis of trust and cooperation between people and social networks, as well as one of the most important interpersonal relationship and an important way for the allocation of resources.

As referred above, we can find that the nature of social capital could be the resource collection embedded in the relational network which can be accessed and used, as well as the trust relationship between individuals or social groups in the network. Social capital includes individual trust and social trust. Fan (2010) formed an enterprise social trust network system, which was consisted of a micro layer, a medium layer and a macro layer. In the system, the medium trust layer includes traditional partners, cooperation business (members of the alliance), the interpersonal trust of enterprises and their marginal organization; the macro trust network consists of companies that aren't directly related with the production or exchange but are outside the environment, for example, governments, associations, and other public organizations, as well as the horizontal or vertical trust given to enterprises by consumers, communities and publications. Pengpeng et al. (2005) divided entrepreneurial social capital into formal networks (e.g., universities, governments, professional and support organizations) and informal networks (e.g., friends, families, colleagues, and informal relationships with high-tech companies).

In conjunction with the literature, the object and the purpose of this study, we define enterprise's social capital as the social relations with governments, banks, universities, research institutes, established in the process of implementing government funded S&T projects, as well as the sum of resources which can be accessed and used. It is represented by the credit and relations with other cooperation organizations, including two aspects–S&T cooperation and social credit.

57.2.2 The Relationship Between Social Capital and Firm Performance

There are many empirical researches about the relationship between social capital and business performance based on the data of different countries and different industries. Gulati and Singh (1998) considered firms were embedded in the relations and structure. Hagedoorn and Schakenraad (1994) analyzed the impact of the number of strategic alliances and interactive relationship of social network on economic performance in information, machinery and petrochemical industries in Europe, America, Japan and other countries, and found that the established strategic social networks could improve the economic performance of organizations. Stuart et al. (1999) found that startup biotechnology enterprises that could establish relationship with well-known enterprises would obtain market opportunities more quickly and get a higher market valuation. Tsai and Ghoshal (1998) analyzed the relationship between social capital and resources exchange and product innovation in large multinational business, and examined the positive impact of social interaction and trust on the exchange of resources between departments, as well as the positive effect on product innovation performance. Baum et al. (2000) found Canadian high-tech companies could use social networks to enhance organizational innovation performance. Lee et al. (2001) found that social capital helped to improve the financial performance of the South Korean technological companies. Chen et al. (2005) believed that if a firm owned more intellectual capital including human capital, structural capital and relational capital, it would achieve the higher innovation performance.

Based on the empirical analysis of the technological innovation of Chinese enterprises, Chen and Li (2001) found that there was a signally positive correlation between enterprise's vertical social capital and technological innovation performance, and a strong correlation between horizontal social capital and technological innovation performance. Zheng et al. (2005) believed that social capital not only helped to reduce the transaction costs of high-tech enterprises, but also helped to improve the technological innovation capability of enterprises. By analyzing the data obtained through the questionnaire survey of 235 Chinese companies, Zhang and Xu (2008) considered social capital was an important factor for Chinese enterprises in the process of innovation, and the impacts of different social capital on knowledge transformation, innovation and performance were different. Chen and Li (2004) conducted a questionnaire survey to a sample of high-tech enterprises in Zhejiang Province, and found that human capital, structural capital, innovation capital and customer capital were signally correlated with business performance.

Overall, most researches on the relationship between corporate social capital and business performance have examined the view that corporate social capital has a positive impact on firm performance.

57.2.3 Research Hypothesis

Every year local governments provide financial assistance to S&T projects declared by local enterprises. In the process of implementing S&T projects, firms gain and use kinds of resources by establishing social relations with research institutes, universities, S&T teams, government departments, banks, and enterprises in the same industry. However, will the social resources and the trust relationships improve the economic performance of S&T projects? This proposition needs to be proved.

There are similarities between economic performance of S&T projects and enterprises. Consequently in this paper, based on the references to studies about the relationship between corporate social capital and firm performance, we propose the following assumption:

Assumption There is a positive correlation between social capital gained by enterprises in the process of implementing government funded S&T projects and the economic performance of S&T projects, which means the more social capital enterprises gain, the better project performance enterprises will achieve.

57.3 Methodology

In this paper we used SPSS (Version 16.0) to analyze the correlation between variables based on the sample, and in the MLR analysis we examined the hypothesis by means of forcing all variables in the model.

57.3.1 Sample

In this study, the data were collected from 64 S&T projects subsidized by Karamay between 2004 and 2008 through a questionnaire survey from August 2010 to January 2011. After the preliminary research and deep interviews to four representative S&T projects financially supported by Karamay, we first sent large scale questionnaires by email, and then invited them to go to the government's S&T sector to have in-depth interviews. We distributed 64 questionnaires, and 48 questionnaires were returned. The recovery rate is 75 %. Overall, five projects are soft researches, and three questionnaires are not completed; so we removed them, at last in this study we used the 40 effective questionnaires as the sample. In addition, Karamay is an oil industrial city, so 90 % of the sample projects belong to the petrochemical industry.

57.3.2 Variables and Measurement

1. *Independent Variable*

The independent variable in this paper is the social capital gained by enterprises in the process of implementing S&T projects. First, we determined how to measure social capital. As it is mentioned in part two, social capital is measured by two factors–S&T cooperation and social credit. Specifically the criteria and definitions included are shown in Table 57.1. As the criteria of S&T cooperation and social credit are all qualitative, we first quantified the raw data, respectively evaluated for every criterion a value between 1 and 5.

Then we constructed the analytic hierarchy model and the judgment matrix to determine the weights of S&T cooperation, social credit and the criteria included. We invited three experts from Karamay to fill in the AHP questionnaire, and used

Table 57.1 Main variables and measurement

Variable	Factor	Criteria	Definition
Social capital	S&T cooperation	Cooperative partners	The social relations with government, research institutes, universities, and banks, which become the long-time cooperation partner
	Social credit	Awards	The awards achievements of projects
		Achievement register	If project achievements were registered in S&T department
		Attention or subsidization	The higher authorities' attention and subsidization
		Bank credit improvements	The bank credit improvements after complement of projects
Economic performance of S&T projects	New products	New products or technology improvements	The number of new products or technological improvement achievements
	Change of product prices or costs	Product prices improvements and costs reduction	The percent of product costs reduction and the percent of product prices promotion after the application of project achievements
	New sales	Sales improvements	The average annual increased sales of project achievements
	New profits	Profit improvements	The average annual increased profits of project achievements

Table 57.2 The weights of criteria based on AHP

Variable	Factor and weights		Criteria and weights	
Social capital	S&T cooperation	0.5	Cooperative partners	1
	Social credit	0.5	Awards	0.325
			Achievement register	0.067
			Attention or subsidization	0.46
			Bank credit improvements	0.149
Economic performance of S&T projects	New products	0.143	New products or tech improvements	1
	Change of product prices or costs	0.075	Product prices improvements and costs reduction	1
	New sales	0.560	Sales improvements	1
	New profits	0.202	Profit improvements	1

the Expert Choice software for the calculation of each indicator weight. All the results have passed the consistency test, and the specific weight values are shown in Table 57.2. Finally we compounded the value of social capital (in this study we named it SC) by hierarchically adding up the product term of criterion and its weight.

2. *Dependent Variable*

The dependent variable in this paper is the economic performance of S&T projects. The financial performance indicators that scholars commonly use in strategic management studies contain ROA, ROE, Tobin's Q and profit growth rate (He et al. 2008). But when did the preliminary research, we found it difficult to obtain data about corporate ROA, ROE, Tobin's Q through questionnaires and in-depth interviews. Therefore, in conjunction of the purpose of this study and the real situation, we used four factors—new products, change of product prices or costs, new sales and new profits to measure economic performance of S&T projects. The data were collected from survey questionnaires and in-depth interviews. We evaluated for every criterion a value between 1 and 5.

We constructed the analytic hierarchy model and the judgment matrix to determine the weights of the four factors and the criteria included. Three experts from Karamay were invited to fill in the AHP questionnaire, and the Expert Choice software was used for the calculation of each indicator weight. All the results have passed the consistency test, and the specific weight values are shown in Table 57.2. Finally we compounded the value of economic performance of S&T projects (in this study we named it ECON) by hierarchically adding up the product term of criterion and its weight.

3. *Controllable Variable*

As the sample data are about S&T projects financially supported by Karamay between 2004 and 2008, the time span is long. We considered the year in which project was started to be implemented (we named it YEAR in this paper) as a

Table 57.3 Results of Pearson, Spearman and partial correlation analysis

Variable	Mean value	Standard deviation	Pearson product-moment correlation		Spearman correlation		Partial correlation	
			SC	ECON	SC	ECON	SC	ECON
SC	2.587	0.819	1		1		1	
ECON	2.721	0.903	0.396*	1	0.380*	1	0.399*	1

Notes *p < 0.5 two-tailed test

controllable variable, rating it between 1 and 5. In addition, government funding for each project is different according to the type of projects. Therefore, we considered the government funded amount (we named it AMOUNT in this paper) as a second controllable variable.

57.4 Results and Discussion

57.4.1 Pearson, Spearman Correlation Analysis and Partial Correlation Analysis

First, Pearson product-moment correlation and Spearman correlation between SC and ECON were analyzed, and then partial correlation between SC and ECON was analyzed when the variables of YEAR and AMOUNT were controlled. The results are shown in Table 57.3.

It can be seen from Table 57.3, Pearson and Spearman correlation analysis and partial correlation analysis between SC and ECON are both significant within the acceptable range ($p < 0.5$). The correlation coefficients (r) are all close to 0.4, so there is a weak correlation between SC and ECON, indicating that there is a certain linear correlation between SC and ECON. When the variables of YEAR and AMOUNT were controlled, partial correlation analysis between SC and ECON passed the test of significance. The correlation coefficient is 0.399, indicating that SC is correlated with ECON.

57.4.2 Hypothesis Test Results and Discussion

In the basic model, there are only the controllable variables including YEAR and AMOUNT, and the dependent variable–ECON. In model 1, SC was included for making multiple linear regression to the dependent variable ECON (see Table 57.4). The variance inflation factor (VIF) of basic model and model 1 are all less than 1.1, and the tolerance limits are more than 0.9, indicating that there is no serious collinearity between variables.

Table 57.4 Results of multiple linear regressions

	Economic performance of projects (ECON)	
	Basic model	Model 1
Constant	*** (4.414)	* (2.359)
YEAR	0.11 (0.065)	−0.065 (−0.407)
AMOUNT	0.105 (0.622)	0.105 (0.671)
SC		0.404* (2.609)
R square	0.12	0.169
Adjusted R square	−0.042	0.099
R square change	0.12	0.157*
F-value	0.217	2.436 f

Notes Sample size N = 40, numbers in the table are standardizing regression coefficient β, numbers in the bracket are T test value of β, f < 0.1, *p < 0.05, **p < 0.01, ***p < 0.001, two-tailed test

The linear regression results show that the hypothesis in this paper could be accepted. The F-value of basic model is 0.217; however, it doesn't pass the significance test, so the basic model is not valid. When SC is included in the model, the R Square (R2) change value is 0.157 in the significant level of 0.1, which shows that the explanatory power of the model has been significantly enhanced. F-value of model 1 is 2.436 in the significance level of 0.1; it passes the significance test, indicating that model 1 is valid. The R Square (R2) of model 1 is 0.169, indicating that the variables (YEAR, AMOUNT, SC) could explain 16.9 % variation of ECON.

In model 1, the standardized regression coefficient of SC is 0.404 (P < 0.1), passing the significance test, that is, when SC increases one unit, ECON would improve 0.404 unit, indicating that there is a significant positive correlation between SC and ECON. In model 1, the controllable variables–YEAR and AMOUNT do not pass the significance test, which may be due to the same type of annual government funded S&T projects and the similar amount of subsidy.

We can make some interpretation for the results. When implementing government funded projects, enterprises would establish a network of social relations with universities, research institutes, S&T teams, or business related enterprises, from which they can gain or use resources, with the result of achieving knowledge transfer with a low cost. By this they could save R&D expenditure, improve the technological content of products, or achieve technical improvements, which would enhance the economic performance of the projects. In addition, through the declaration of the Government's Technology Fund or S&T awards, enterprises could construct social relations with governments and then improve corporate social credit. Because the permission of the principal leaders of the local government is great and integrated, the resources enterprises obtain from them are abundant, so the social credit accumulated by the declaration of the government funded projects helps to improve the economic performance of the projects.

57.5 Conclusion

In this paper, we further confirmed the positive correlation between corporate social capital and economic performance, and extended the research objects to the S&T projects, and got some meaningful conclusions. We first founded the index system for social capital and economic performance of government funded S&T projects in conjunction with professional opinions and AHP. Social capital was measured by two factors–S&T cooperation and social credit, and economic performance of S&T projects was measured by four factors—new products, change of product prices or costs, new sales and new profits. Then we have examined that there is a positive correlation between economic performance of the local government funded S&T projects and corporate social capital accumulated in the implementation of the projects by the means of setting up the linear regression model, concluding that the more the accumulation of social capital in the process of implementation of government S&T projects, the better the economic performance of the projects.

We can give some advice to enterprises. For example, in the process of implementing S&T projects enterprises could achieve social capital through long term cooperation with universities, research institutes and social organizations or other enterprises, thus improving the economic performance of the project; they could improve the social credit by declaring all kinds of governmental S&T awards, in order to get the concern of government departments, gaining the support of the banks, and these would help to improve the economic performance of the S&T projects.

With the limitations of sample size and sample data quality, the statistic significance of the variables in the multiple regression models is not very significant. As the variable of social capital in the model is a composite variable, so in future the impact of the factors of social capital on the project economic performance could be researched.

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Chapter 58
Status and Prospect on Converging Technology: Technology Management Perspective

Hong Miao, Li-fang Qin and Lu-cheng Huang

Abstract Converging technology has received much attention from scholars at home and abroad in recent years. From the technology management perspective, this study classified the existing literatures as four aspects: the inevitability of its emergence and the concept, the impact it brought, the analytical methods, convergence status and developing trend. According to the above four aspects, this study compared the similarities and differences between domestic and foreign studies, analyzed the inadequacies of the current study and further probed into the direction of future research.

Keywords Converging technology · Literature review · NBIC · Technology management

58.1 Introduction

Converging technology was first put forward in the meeting of technology integration jointly organized by the U.S. Department of Commerce (DOC) and the U.S. National Science Foundation (NSF), in December 2001, which refers to the convergence among nanotechnology, biotechnology, information technology and cognitive science (NBIC) (Roco and Bainbridge 2002). Converging technology has significant characteristics: (1) these four technologies are highly complementary. Converging technology was material unity and technology integration based on nano-scale, that was, converging technology took biology especially the nervous system as an object, information technology as a tool to reveal and enhance the intelligence (Naiji 2008). Roco and Bainbridge 2002) in Rensselaer

H. Miao · L. Qin (✉) · L. Huang
School of Economics and Management, Beijing University
of Technology, Beijing 100124, China
e-mail: qinlifang0411@163.com

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Polytechnic Institute of America described the complementary relationship among these four technologies vividly: “If the cognitive scientists could think about it, nanotechnology scientists could manufacture it, biological scientists could use it, and information scientists could monitor and control it.” (2) converging technology will actively promote the development of human society, that is, it will not only produce new high-tech and new industry to optimize the socio-economic and industry structure, but also change the way of life and cognitive, triggering a new round of scientific and technological revolution. Because of the significant characteristics, converging technology had received great attention from scholars at home and abroad since it was put forward. So far, many studies about converging technology had been launched, achieving some results. But there were still many inadequacies need to be explored in future research. For this reason, summarizing the research status timely will have great importance to the further research. However, there hardly any studies about this at home and abroad. In this case, this study summarized the latest research progress and analyzed the different focus of research at home and abroad. Besides, this paper pointed out the inadequacies of present studies and probed into the direction of future research.

The present studies mostly included the following aspects: (1) the inevitability and connotation of converging technology; (2) the impact brought by converging technology; (3) the analytical methods for converging technology; (4) convergence status and developing trend of converging technology. From the technology management perspective, this study summarized the existing literature according to these four aspects.

58.2 The Connotation and the Inevitability of Converging Technology

58.2.1 The Inevitability of Converging Technology

The emergence of converging technology was inevitable. First, the development of nanotechnology, biotechnology, information technology and cognitive science in their respective areas had made preparation for the convergence among them; Second, N–B-I–C are complementary; Third, the emergence of NBIC was adapt to the convergence trend technologies and science conformed to.

From different perspective, many scholars analyzed the inevitability of its emergence, such as from the perspective of background against which it emerged, the development of disciplines, philosophy, technology development and form of motion. Taking time as a clue, Wang et al. (2004) and Wenxian (2006) traced the historical process, from the occurrence of technology confusion to the establishment of converging technology, and further revealed the origin of converging technology. Zhang and Luo (2005) pointed out that the cross-linkages among disciplines continued to strengthen and the breakthrough of technology in one area depended on multi-disciplinary knowledge and technological progress in other areas. Converging technology was the product of such collaborative development among disciplines. Analyzing from the perspective of philosophy, Junjie (2003) suggested that “long divided, must unite; long united, must divide” was also the law which the development of technology followed and convergence was the general trend which the development of technology and science conformed to. Analyzing the development of technology and the form of motion, Naiji (2008) thought that converging technology was consciousness technology and was the inevitable trend of development of technology.

58.2.2 The Concept of Converging Technology

The present studies elaborated the concept through analyzing the essence and characteristics of converging technology. The report of Converging Technologies-Shaping the Future of European Societies pointed out converging technologies were enabling technologies and knowledge systems that enabled each other in the pursuit of a common goal (Nordmann 2004). Naiji (2008) pointed out that converging technology, whose nature was the unity of man–machine, had such characteristic that science and technology were integration intrinsically; the Humanities and Social Science were integration. In addition, Rosenberg (1963) defined technology convergence as technological revolutions emerging from collaboration phenomena where diverse industries were struggling to solve their own technological problems. Kodama (1995) suggested that technology fusion was fusion and breakthrough of diverse technologies at the same time and it had the characteristics that the property of each elemental technology was perished.

58.3 The Impact Brought by Converging Technology

Converging technology not only impacted the various aspects of current social life, but also had significant impact on the long-term development of society. The impact included positive and impassive aspects. The study of the impact would provide an effective reference point for the further development of converging technology.

58.3.1 The Macro Impact of NBIC and the Countermeasures

Many scholars believed that converging technology would impact the development of society positively (Junjie 2003; Cai 2011; Zhao 2007). NBIC might improve the innovative capability of society, guarantee national security, promote the sustainable development of human society and bring sustainable development outlook of scientific. Nevertheless, there were also some scholars believed that converging technologies would brought new challenges. Grunwald (2007) put forward that converging technology improved human performance and decreased its dependency on the given, however, it also increased the problems of orientation, such as cultural orientation, technological development orientation and human nature. Swierstra (2009) analyzed the challenge which converging technology imposed on symbolic order and pointed out it should be governed by the ideal of "human sustainability".

58.3.2 The Micro Impact of NBIC and the Countermeasures

The present literature analyzed the micro impact mainly from the perspective of discipline development, education and S&T management. Li (2007) and Xiang (2006) believed that the cross-penetration between disciplines was increasingly strong and the convergence among disciplines became the new trend of the knowledge production. Huang (2008) believed that, under the dominance of converging technology, there would be new trend of technical development which was scientific unity and technical convergence, thus breaking off the old model of education and bringing reform of medical education. Zhang (2005) believed that converging technology would impact technology management department on selecting priority area, creating research infrastructure and making plan for development.

58.4 The Analytical Methods of Converging Technology

The studies about the analytical methods for converging technology mainly included the following aspects, which could afford effective model and method for technology managers to make decision about the development of converging technology.

Yasunaga (2009) put forward that it was viable to apply technology roadmaps to governmental innovation policy for promoting technology convergence. To help managers to select project and investment better, Cunningham (2009) explored an approach closely related to MCDA, known as exchange modeling, whose advantage was that the results provided an improved prescription for strategy, given the constraints of preferences and existing alliance structures. Converging technologies demanded new forms of social, economic and technological coordination. The coordination of converging technology was increasingly a large-scale, high-risk enterprise, requiring the formation of partnerships and alliances. As to the coevolutionary cycles of convergence, Hacklin (2009) applied multi-case study approach to the convergence within ICT and then transferred the reasoning within the ICT case set onto the nano- and bio-technologies, deriving recommendations from a retrospective to a predictive context. Jin et al. (2011) used a R&D network to find out the research trend of converging technology and important experts, whose advantage was using multi-sources rather than using only one database. Regarding to the forecast of converging technology, Guild (2007) put forward using expert knowledge to envision future converging technology, which was collecting information from a group of experts and key players from different areas using the repertory grid technique.

58.5 The Convergence Status and Developing Trend of Converging Technology

Although most of the literature elaborated this issue qualitatively, only a few using the quantitative analysis, it could still be found that the convergence between any two sub-technologies of N–B-I–C had made great progress, even being applied to real life. The convergence among three or more technologies was on the horizon and converging technology would continue to develop toward the direction of convergence among multiple technologies.

First, the convergence between nanotechnology and biotechnology had occurred widely and been applied to fields of life sciences and biomedical. Zhang (2006) and Fortina (2005) elaborated the research progress, application and forecasted the future research and application prospects. Chunjuan (2010) analyzed N–B converging technology via patentometric and information visualization techniques. The results showed that N–B converging technology developed rapidly in years 2000–2009. Roco (2003) believed that nanotechnology provided the tools to measure and understand biosystems which offered models of inspiration for nanotechnology.

Second, compared to the nano-biotechnology, the literature on the B–I convergence was slightly fewer. But it was also a hot field of current research and the convergence in some area had occurred. Zhao (2003) elaborated the priorities in research, development and application of B–I. Based on that, the future development and prospect was analyzed qualitatively. He and Sun (2011) analyzed the hot issue and prospected the future development.

Finally, Zhao (2007) wholly summarized the progress and breakthrough converging technology had made in recent years: (1) the convergence between biotechnology and information technology; (2) the development of nanotechnology and micro-optoelectronic devices; (3) the convergence among N–I-C. Through quantitative analysis, Ren (2007) concluded that nanotechnology gradually penetrated to the IT and developed toward the direction of application research and industrialization. Jones (2007) and Phan et al. (2009) analyzed the existing convergence among nanotechnology, biotechnology, and information technology and stated the application in medical.

58.6 Review and Prospect

Although many studies about converging technology had been carried out at home and abroad and had made some progress, there were still many differences between domestic and foreign research.

While the Chinese scholars mainly used the method of qualitative analysis, the foreign scholars emphasized more on quantitative analysis and proposed numbers of methods and models to analyze converging technology. While the domestic research involved a wide range, such as the concept, inevitability, impact and status of convergence, the foreign study mainly focused on the analytical method for converging technology.

58.6.1 The Concept of Converging Technology

Converging technology had no uniform name in domestic literature, which reflected there was no clear grasp of its connotation, thus this issue needed in-depth research and analysis.

58.6.2 The Focus, Hot Areas and Direction of Development

The majority of literature was limited to qualitatively expatiate on the progress, the focus and future development of NBIC, the objectivity and accuracy of which needed to improve. Therefore, later researchers can apply patent citation analysis and patent visualization analysis to study the direction of development, apply patent IPC classification analysis to study the frontier and hot field.

58.6.3 The Convergence Status of N–B-I–C

Besides convergence between any two sub-technologies, multiple sub-technologies could also form convergence network. But there was less literature quantitatively analyzing the convergence among three or four sub-technologies, which didn't reflect the real trend of convergence and didn't contribute to the discovery of technical chance. Later researchers can apply the ICP correlation analysis and dynamic network analysis to analyze the convergence network and the trend among multiple sub-technologies of NBIC, which needs further verification, however.

58.6.4 The Impact on Technology Management

The majority of present studies were about the macro impact on society. There were fewer scholars studying the impact on technology management. For instance, the studies about the interactions, the way and the process of diffusion among N–B-I–C were rare. Besides, the impact on industrial development and industrial cluster, brought by NBIC, also needed further study.

58.6.5 Quantitative Method for NBIC

There was lesser literature studying the quantitative method for NBIC. Furthermore, the domestic study was almost blank. Therefore, there are numbers of issues about the analytical method worthy of deep thinking: how to analyze the converging trend; how to quantitatively analyze rather than qualitatively analyze the impact on society.

58.6.6 Suggestions to Promote the Development of NBIC

The existing suggestions about promoting the development of NBIC were mostly on the level of system and mechanism while that on the level of technology were rare. In view of that, future researchers can propose targeted suggestions for the choice of priority and R & D strategy through studying the key technology and its law of variation which could be obtained through analyzing the developing and converging trend of NBIC.

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Chapter 59
A Model of Product Development Team Knowledge Creation from a Behavioral Perspective

Xian-guo Zhang

Abstract Team knowledge sharing is a fundamental way of team knowledge creation. By taking knowledge sharing behavior as the analysis unit and integrating the constructs of team psychology safety and shared knowledge, a comprehensive model of product development team knowledge creation is constructed from a behavioral perspective, which is distinct to the exiting models. The model has the fallowing points: First, the team members' individual traits, attitude toward, subject norms concerning, and perceived control of knowledge sharing behavior have direct effect on his knowledge sharing behaviors. Second, team psychology safety has positive effect on individual members' knowledge sharing behaviors. Three, the tacitness of knowledge has negative effect on individual's knowledge sharing behaviors. Fourth, individual members' knowledge sharing behaviors have positive effect on the team knowledge creation. Fifth, team shared knowledge as a moderator between individual knowledge sharing and team-level knowledge creation can facilitate the transforming of individual knowledge to team knowledge.

Keywords Knowledge management · Team learning · Shared knowledge · Knowledge creation

59.1 Introduction

Product development plays an increasing important role in today's business competition. From the viewpoint of knowledge management, product development can be viewed as a collective knowledge creating activities, and successful product

X. Zhang (✉)
Business School of Guangzhou University, Guangzhou, China
e-mail: zxguo@21cn.com

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development needs effective integration of multiple kinds of special knowledge (Madhavan and Grover 1998; Zhang and Yang 2007). Product development team is the subject of product developing, and it can be taken as a distributed cognitive system (Hutchins and Klausen 1996; Tsoukas 1996)· The literatures on distributed cognition and knowledge integration both support that knowledge sharing can create common understanding and fulfill the integration of knowledge (Hutchins and Klausen 1996; Tsoukas 1996; Okhuysen and Eisenhardt 2002), so the creation of product development team knowledge can be studied from knowledge sharing. The fallowing parts of this paper are organized as below: the main concepts are firstly defined, and then the conceptual framework is put forward and the hypotheses are proposed.

59.2 Methodology

59.2.1 Definition of Constructs

Knowledge sharing is defined as an social interactive process which includes behavior motivating, knowledge transporting, and knowledge understanding (Zhang 2007). Hansen (1999) thinks knowledge sharing is a searching, distinguishing, moving and incorporating process. Knowledge moving means the sending and receiving of knowledge, and knowledge incorporating means the understanding of knowledge. **Team knowledge creation** is defined as newly created team-level collective knowledge basing on the members' knowledge sharing behavior activities. According to the theory of group dynamics (Okhuysen and Eisenhardt 2002; Thomas-Hunt et al. 2003), team can be viewed as a distributed cognitive system consisting of more than two members, basing on its members' knowledge sharing, team collective results that beyond individual knowledge sharing can be created.

59.2.2 Conceptual Framework

The factors that have major influences on knowledge sharing are the participating subjects of knowledge sharing, the nature of knowledge and the background of knowledge sharing behaviors (Zhang 2007), so this paper wants to build the framework on the individual member's subjective factors, the nature of knowledge and the team context. Knowledge sharing is a rational behavior of knowledge worker, and it is guided by his inner intention. As the literature has pointed out that knowledge sharing behavior is depend on the willingness of the knower (Nonaka 1994), so based on the theory of Planed Behavior (Bock et al. 2005), the model analyzes the individual's traits on his knowledge sharing behavior from attitudes, norms and perceived controlling of the behavior.

The nature of knowledge should be considered in the model, because the members must give out his knowledge before the knowledge sharing behavior, and the tacitness of knowledge has strong effect on knowledge sharing behavior (Nonaka 1994; Zhang and Yang 2007). In the context of team, the individual's knowledge sharing behavior will be influenced by the team level factors, which are analyzed from team psychological safety and shared knowledge in this paper. Firstly, team knowledge sharing is a kind of team learning, research on team learning has showed that team psychology safety has strong effect on knowledge sharing behavior (Edmondson 1999). Secondly team shared knowledge will facilitate the mutual understanding among the members (Cramton 2001), but product development team knowledge sharing is cross specials (Madhavan and Grover 1998), and the shared knowledge among members coming from different knowledge domains is always not enough.

59.3 Hypothesis Developing

59.3.1 Individual's Attitude Toward Knowledge Sharing Behavior

One's attitude toward behavior is his positive or negative judgment about the behavior. The social psychology has proved that when the individual's attitude is powerful and directly related to the observed behavior, the attitude can exactly forecast the behavior (Bock et al. 2005). If the members have explicit knowing on the usefulness of knowledge sharing and can get self-successfulness and good reputation (von Krogh 2002), then he is more likely to give out his personal knowledge. If the members know that knowledge sharing can improve his work and is willing to ask for knowledge from others, the he will be more likely to send out knowledge-asking for behavior. Relevant research has reported the positive relationship between attitude toward knowledge sharing and the behavior (Bock et al. 2005), so the below hypothesis can be proposed:

H1: One's attitude toward knowledge sharing is more positive, he is more likely to perform knowledge sharing behavior.

59.3.2 Individual's Subjective Norms on Knowledge Sharing Behavior

One's subjective norms are his internalized, related to particular behavior social norms. Knowledge sharing is a social interactive behavior, and researches have showed that reciprocity, altruism, and trust are social norms facilitating knowledge sharing (Nonaka 1994; von Krogh 2002). The altruism norm is mainly concerned to knowledge provider, one who is more altruistic he will more likely to perform helping behaviors. The trust and reciprocity norm are both concerned to the knowledge provider and receiver. The provider should trust the receiver's goodness and ability, and think the knowledge is useful to others and cannot damage self-interest (von Krogh 2002). The receiver can trust that the knowledge is the best and reliable, and can be learned and used safely. As analyzed above, the below hypothesis can be proposed:

H2: The norms of reciprocity, altruism, and trust are more deeply internalized by the individual, and then he is more likely to perform knowledge sharing behavior.

59.3.3 Individual's Perceived Controlling of Knowledge Sharing Behavior

Perceived controlling of behavior is one's perception of the difficulty to complete particular behavior. Knowledge sharing behavior is not costless, for example, it consumes time and effort (Hansen 1999), which are the direct cost. At the same time, knowledge sharing behavior may lead to some negative results, such as the delay of one's own work and the misuse of the given out knowledge. So if the result of the behavior is more difficult to forecast or the result is thought to be more negative, the individual's knowledge sharing behavior will be more difficult to motivate. And the below hypothesis can be put forward:

H3: The stronger of one's perceived controlling of knowledge sharing behavior, the greater possibility for he to perform the behavior.

59.3.4 Team Psychology Safety and Individual Knowledge Sharing Behavior

In the social context of team, the members' knowledge sharing behavior will be influenced by the social factors within the team. Edmondson (1999) has found that the learning behaviors in team are facilitated by the team's psychology safety. Knowledge sharing in team is characterized by openly putting forward one's opinions or asking for other members, so knowledge sharing behaviors in team context not only have the direct cost of behavior and face the social interpersonal risk. Team psychology safety as a kind of social force has positive effect on the members' knowledge sharing behavior:

H4: Team psychology safety has positive effect on the individual member's knowledge sharing behavior.

59.3.5 Tacitness of Knowledge and Individual Knowledge Sharing Behavior

The tacitness of knowledge can have effect on individual knowledge sharing behavior from several ways. Firstly, if the knowledge to be shared is the daily common knowledge, then it is easily neglected and the individual cannot consciously give it out for sharing (Nonaka 1994; Zhang and Yang 2007), so the knowledge sharing behavior is directly hindered. Second, if the knowledge is an immature and in-becoming one, its sharing needs further conscious process (Zhang and Yang 2007), and then the sharing behavior will be difficult to take place. Last, if the knowledge is the expertise, which needs long time to learn and cumulate and is the member's core ability, so the willing to sharing it is always low (Hoopes and Postrel 1999). The above analysis leads to the fallow hypothesis:

H5: The tacitness of knowledge has a negative effect on individual's knowledge sharing behavior.

59.3.6 Individual Knowledge Sharing Behavior and Team Knowledge Creation

Knowledge sharing needs the expressing out of one's knowledge, which can motivate the knowledge provider's reflecting on his knowing and deepens the understanding of the knowing (Zhang and Yang 2007). As to the knowledge acceptor, successful knowledge sharing can provide new knowledge and views to him, which helps the acceptor to build more comprehensive understanding about his work and the product (Hoopes and Postrel 1999). The team should create integrated new knowledge basing on the mutual understanding among its members, as the researches on group dynamics have shown that the members' interaction are the basis of group behavior (Okhuysen and Eisenhardt 2002). Okhusen and Eisenhardt (2002) have pointed out that the essential work of team is to integrate individual knowledge into collective knowledge, and knowledge sharing is a fundamental interaction centering on knowledge exchanging and reusing (Okhuysen and Eisenhardt 2002), which can lead to new knowledge creating. So hypothesizes can be deduced:

H6: Individual knowledge sharing has a positive effect on team knowledge creation.

59.3.7 *The Moderating Effect of Shared Knowledge on Team Knowledge creation*

Shared knowledge is a team level constructs, which means the overlapping of the members' knowledge domain and quantity. Shared knowledge is tacit and can tacitly facilitate the sharing of knowledge among team members (Hoopes and Postrel 1999). According to communication theory, shared knowledge not only helps members to exactly understanding the exchanged knowledge, but also leads to more effective knowledge sharing by selecting relevant knowledge to exchange, so that the individual knowledge sharing behavior can be more effectively transformed into team knowledge (Cramton 2001). Bechky (2003) has found that shared knowledge is helpful for the knowledge receiver to reconstruct and transform the knowledge (Bechky 2003), and the lacking of shared knowledge has been proved to hinder team knowledge sharing (Hoopes and Postrel 1999). So it is can deduced that:

H7: Shared knowledge has a moderating effect on individual knowledge sharing behavior and team knowledge creation.

59.4 Conclusion

This paper believes that the individual knowledge needs to transform into team knowledge, which means the integration of team members' personal knowledge. From a behavioral perspective, a model of product development team knowledge creation is developed, which consists of seven hypotheses and has the fallowing implications.

First, this paper researches team level knowledge creation in the context of product development team, so the gap of team level knowledge creation is filled. The constructed model examines the motivation of knowledge sharing behavior and knowledge understanding, and analyzes the sharing behavior and its outcomes, together with the transforming from individual to team level, which deepens the theory of knowledge creation.

Second, the creation of team knowledge by integrating of multiple specialties in product development is studied from the perspective of knowledge sharing, which deepens the understanding of the integrating creation of knowledge and can helpful to the management of product development. The model shows that product development team sharing is influenced by the individual member's inner belief and intent and the outward team psychology safety, further more by the tacitness of knowledge and the team shared knowledge. So in order to fulfill the potential and dig out the members' unique knowledge, the manager should have explicit knowing on the relationship and the interactive paths among these factors, and chooses relevant management tools by analyzing the above variables of his team.

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Chapter 60
Influencing Factor Analysis of College Students' Learning Interest in Specialized Courses by Rough Set Theory

Wen-zhun Huang, Ying Wang and Zheng-guang Zhou

Abstract The learning interest plays an important role in college students' specialized course learning and teachers pay much attention to it in teaching activities. In this paper, first, a questionnaire survey is administered and related data collected; and then by using rough set theory the relationship between students' interest in specialized course and the influencing factors is analyzed; and when the data for importance degree of all the factors are known, theoretical foundation about how to improve students' interest in specialized course teaching activities is established. And with MyRS tool, it is concluded that teaching level of specialized courses is the most important to college students' learning interest.

Keywords Learning interest in specialized course · Teaching level of specialized courses · Rough set · MyRS tool

60.1 Introduction

Psychologists believe that interest is a favorable disposition towards acquiring knowledge. When the individual is learning in joy triggered by interest, this primary form of value concept, will generate a positive emotional experience, which plays significant role in promoting the individual's cognitive activities and gradually develops into an internal motivation of individual activity (Salas et al. 2009; Yang et al. 2006; Trimmel and Bachmann 2004). Physiologically, excitement aroused by interest can lead to excitement, which will increase amounts of

W. Huang (✉) · Z. Zhou
Department of Engineering Technology, Xijing University,
Xi'an 710123, China
e-mail: wenzhunw@126.com

Y. Wang
Department of Human Sciences, Xijing University, Xi'an 710123, China

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glucagon in the blood and promote secretion of the thyroid. In this way, as a material basis for the improvement of the learning efficiency, the metabolism is accelerated, the mental power boosted and the learning stamina increased. Psychologically, it is generally thought that the generation of interest stems from cognitive surprise and emotional attraction. A surprise occurs when a concept similar to and associated with the past experience rises; but it cannot thoroughly assimilate the established cognitive structure; otherwise would trigger off conflict between curiosity and concept (Eisenberg et al. 2010).

From past to present, many world famous educators have noted the role of interest in teaching activities. Johann Amos Comenius, a Czech educationalist, pointed out in his *Didactica magna* that, "A good learning method should be motivating children to seek knowledge enjoyably and could encourage them to study with all possible ways. On the contrary, a way based on forcing children to learn would be greatly harmful to them" (Blair 2000). In light of the above, it is very important for senior college students to build up interest in learning specialized fundamental courses because interest is always contributing to an outstanding academic performance and a strengthening competence in engineering practice (Vaidyanathan 2011).

First, learning interest can improve the cognitive quality of specialized and professional knowledge. As interest is one of the important aspects of motive, learning is explicitly orientated. Second, this important source of motivation can generate awareness by internal driving force and its specific manifestation is the following: the broadened scope of attention, the increased persistence of attention, and the improved memory as well. As a matter of fact, learning interest in specialized course can bring about a positive emotional experience and to great extent, reduce fatigue. Third, once senior college students develop a passion for specialized knowledge whereby to form the positive knowledge-seeking desire, the desire will spark and ignite their learning interest in specialized courses. Inevitably, the delightful effect will make the students be in relaxed state and make them immerse in such contentment experience. Referring to the relevant literature in References (Shin t al. 2011; Peng et al. 2010; Shu and Chung 2009), by using Rough Set Theory and with the aid of MyRS tool, the importance degree indexes of various factors influencing college students' academic performance have been compared. As a result, it comes to a conclusion that the learning interest of the senior college students is the most active factor that influences their academic performance in specialized course learning.

60.2 The Rough Set Theory

The Rough Set Theory (RST) was proposed by Professor Pawlak in 1982. Owing to its multiple advantages, RST has been widely used in such fields like artificial intelligence, machine learning, knowledge acquisition, decision analysis, pattern recognition and so on. RST can be applied in handle the imprecise interclass boundaries problems of "rough classification". The method philosophy is based on the assumption that an object must be affiliated with some information. And because of the very information, objects characterized by the same information are indiscernible. Correspondingly, the indiscernibility relation built in such way supplies a mathematic basis for the rough set theory. When a decision is made by using rough set theory, above all, the valuable information can be gathered from the given data set; and after data compression, reduction and analysis of attribute importance, a reasonable decision scheme is generated (Pawlak 1991).

Definition 1 (Cheng et al. 2011; Meng and Shi 2009) Assume that U is the universe of discourse, a nonempty finite set, and $R \subseteq U \times U$ is a binary equivalent relation on U, then $A = (U, R)$ is named approximation space, in which [x] is R equivalence class for the object. For any $X \subseteq U$, X is represented by $\underline{R}X$ and $\overline{R}X$. $\underline{R}X$ and $\overline{R}X$ are:

$$\begin{aligned} \underline{R}X &= \{x \in U | [x] \subseteq X\} \\ \overline{R}X &= \{x \in U | [x] \cap X \neq \varphi\} \end{aligned} \tag{60.1}$$

Here $\underline{R}X$ is Lower approximation and $\overline{R}X$ upper approximation. The elements in $\underline{R}X$ are classified as sure members of X by the knowledge in R; but the elements in $\overline{R}X$ are possible ones. The set X is referred to as a rough set which is approximated using information contained in R by constructing lower and upper approximation sets. Hence, positive field $pos_R(X)$, boundary region $bn_R(X)$, and negative field $neg_R(X)$ are defined as:

$$\begin{aligned} pos_R(X) &= \underline{R}X \\ bn_R(X) &= \overline{R}X - \underline{R}X \\ neg_R(X) &= U - \overline{R}X \end{aligned} \tag{60.2}$$

Definition 2 (Hong et al. 2000) The rough set method is a series of logical reasoning procedures to analyze an information system which is seen as a decision table; and the system can be denoted by $S = (U, A, F)$, where U is a limited object set represented by $U = \{x_1, x_2, \cdots, x_n\}$, A is a limited attribute set called $A = \{a_1, a_2, \cdots, a_n\}$, and a correlation set between U and A is F, i.e. $F = \{f_i | j \leq m\}$, where $f_i : U \rightarrow V_j, j \leq m$, V_j is called the domain of a_j, and the value of V_j can be either quantitative or qualitative. F(x) reflects complete information of object x in the system S, and F(x) is often called the information function. For this information system, each subset of attributes $B \subseteq A$ could define a binary equivalence relation R_B on the universe of discourse U as:

$$xR_By \Leftrightarrow f_j(x) = f_j(y), \forall a_j \in B \tag{60.3}$$

In the rough set, A is a set of primitive features, and C and D are two subsets of features; it is assumed that there is $C \cap D = \Phi$, where C is called the condition feature and D the decision feature. The information system A is called the decision table often noted as $(U, C \cup D, F)$. R_c generated by U is defined as $U/R_c = \{C_1, C_2, \ldots, C_i\}$; R_D by U as $U/R_D = \{D_1, D_2, \ldots, D_J\}$. C positive field of D is expressed by $pos_C(D)$ denoted as $pos_C(D) = \bigcup_{j=1}^{J} \underline{R_C}(D_j)$ and $\gamma_C = |pos_C(D)/|U||$, where $|X|$ is the number of elements in the set X, and U is the universe of discourse.

Definition 3 (Kim et al. 2007) Assume that $(U, C \cup D, F)$ is a decision table, where C is called the condition attribute set, and D the decision attribute set, and then the importance of attribute subset $C' \subset C$ for D is

$$\sigma_{CD}(C') = \gamma_C(D) - \gamma_{C-C'}(D) \tag{60.4}$$

where $\gamma_C = |pos_C(D)|/|U|$, particularly, when $C' = a$, the importance of attribute $a \in C$ for D is

$$\sigma_{CD}(a) = \gamma_C(D) - \gamma_{C-a}(D) \tag{60.5}$$

60.3 Important Factor Analysis of Learning Interest

60.3.1 Collection of Raw Data

By questionnaire and with random sampling the third year undergraduates in Xijing University were investigated on the factors of interest influencing learning the specialized courses. With 110 questionnaires handed out and 104 valid questionnaires taken back, the recovery rate of the questionnaire is 95 % or so.

Firstly, the mapping relationship was established between interest in learning the specialized courses and its influence factors from paper questionnaires. Secondly, the influence degree of the various factors on the decision attribute was analyzed by rough set theory.

In the questionnaire survey, 10 questions with a 4-point Likert scale were asked: (1) How do you think about the teacher's teaching attitude to professional courses? (a. very serious; b. serious; c. still line; d. not serious) (2) Can the praise from your teachers arouse the enthusiasm of your learning professional courses? (a. It can largely improve the enthusiasm of learning the professional courses; b. It can temporarily improve the enthusiasm of learning the professional courses; c. It can rarely improve the enthusiasm of learning the professional courses; d. It cannot improve the enthusiasm of learning the professional courses.) (3) How do your teachers manage the specialized course classrooms? (a. very severe; b. severe; c. less severe; d. it doesn't matter.) (4) How is the teaching level of your professional course teachers? (a. very high; b. high; c. average; d. low.) (5) How is the teachers' attitude to students? (a. very amiable; b. amiable; c. indifferent; d. extremely

Table 60.1 Questionnaire of professional courses learning interest

No.	The condition feature(C)									D
	x_1	x_2	x_3	x_4	x_5	x_6	x_7	x_8	x_9	
1	a	a	a	b	b	d	b	a	c	b
2	c	b	a	c	b	c	d	b	c	c
3	c	b	b	c	b	c	c	a	c	b
4	b	b	b	b	b	a	a	a	a	a
5	a	a	a	a	a	a	a	a	a	a
6	a	a	b	a	b	a	a	a	a	a
7	d	d	c	b	b	d	b	b	c	b
8	b	b	b	a	b	d	b	b	b	b
……										
103	a	a	b	a	a	d	b	b	d	b
104	b	b	a	b	c	c	c	b	c	b

indifferent.) (6) Is the cramming method reasonable for professional courses? (a. very reasonable; b. reasonable; c. relatively reasonable; d. unreasonable.) (7) How do you like your major? (a. I like a lot; b. I like; c.I moderately like; d. I dislike.) (8) What is the employment competition like in this day and age? (a. extraordinary fierce; b. fierce; c. relatively fierce; d. not fierce.) (9) Is the curriculum of professional courses reasonable? (a. very reasonable; b. reasonable; c. relatively reasonable; d. unreasonable.) (10) Are you interested in learning your specialized courses? (a. very interested; b. interested; c. little interested; d. not interested.)

The mapping in Table 60.1 shows the learning interest of 104 senior college students and its influencing factors. In the table, C is called condition feature set and composed of the attributes x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9 representing question 1–9 respectively in the questionnaire. D, the decision feature, represents the 10th question, and the answer No. represents each attribute value. Due to the limited space, only part of data is given.

60.3.2 Establishing the Decision Table

MyRS, which is a cross-platform development tool system of rough set realized in Java programming language, is composed of GUI and core computing of rough set. By using the functions of input/output, data pre-processing and core computing, MyRS can realize the classical algorithm about positive field, kernel, attribute reduction and rule extraction (Wei and Li 2010).

As for the data-entry format, file of MyRS adopts the CSV format which can be realized by Microsoft Excel software. The decision table could be established by setting the weight for the attribute based on the importance of it; and the students' answers a, b, c and d set the weight 4, 3, 2, and 1 respectively.

60.3.3 Computing the Indicators of Condition Attributes

The significance of attribute can be calculated by MyRS tool. When the attribute is removed, the greater the classification variability, the higher attribute importance degree is, and vice versa.

The significance of every attribute about D is:

$$
\begin{aligned}
\sigma(x_1) &= attr0 = \gamma_C(D) - \gamma_{C-(x_1)}(D) \approx 0.058,\\
\sigma(x_2) &= attr1 = \gamma_C(D) - \gamma_{C-(x_2)}(D) = 0,\\
\sigma(x_3) &= attr2 = \gamma_C(D) - \gamma_{C-(x_3)}(D) \approx 0.029,\\
\sigma(x_4) &= attr3 = \gamma_C(D) - \gamma_{C-(x_4)}(D) \approx 0.096,\\
\sigma(x_5) &= attr4 = \gamma_C(D) - \gamma_{C-(x_5)}(D) = 0,\\
\sigma(x_6) &= attr5 = \gamma_C(D) - \gamma_{C-(x_6)}(D) = 0,\\
\sigma(x_7) &= attr6 = \gamma_C(D) - \gamma_{C-(x_7)}(D) \approx 0.029,\\
\sigma(x_8) &= attr7 = \gamma_C(D) - \gamma_{C-(x_8)}(D) \approx 0.019,\\
\sigma(x_9) &= attr8 = \gamma_C(D) - \gamma_{C-(x_9)}(D) \approx 0.029
\end{aligned}
$$

where $\sigma(x_1)$ is the significant degree of condition attribute 1, and $\sigma(x_2)$ the significant degree of condition attribute 2, and so on.

Thus, the significant degree relationship of the factors influencing learning interest of professional course is:

$$
\begin{aligned}
&\sigma(x_4) > \sigma(x_1) > \sigma(x_3) = \sigma(x_7) = \sigma(x_9)\\
&> \sigma(x_8) > \sigma(x_2) = \sigma(x_5) = \sigma(x_6)
\end{aligned}
$$

60.4 Discussion

According to the calculation result of the conditional attribute indicators, through sorting important attributes influencing learning interest of professional course, it is found that the teaching level of the specialized courses is the most important. The teaching attitude is the second important except the teaching level. The requirements of the classroom discipline and enjoyment about learning the specialized courses are less important than the teaching attitude. The teachers' praise and attitude are the least important, which can only temporarily stimulate interest in learning the courses. Therefore, the three attributes—the teaching level of the specialized courses, the teaching attitude and the requirements of the classroom discipline—are key to improve college students' interest in learning specialized courses.

60.5 Conclusion

Based on the above analysis, we know that college students' learning interest is key to improve students' performance and the teaching level of professional course and teaching attitude are the core factors to stimulate the learning interest. And by using of rough set theory, the attributes influencing college students' learning interest in the specialized courses is classified by the way of reduct rules. And the significant degree of every attribute can provide effective method to improve learning interest of individual learners. The results could be obtained collecting data in rough set decision table and analyzing appropriate attributes with MyRS tool.

Although the theory of rough set is used in many study fields, it is not fully used in a specialized course learning system. And this research tries to make it possible.

With MyRS, the significant degree of the usable and necessary data can be easily obtained, when amounts of data greatly increased in the decision table, the tool is highly suggested.

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Chapter 61
Reflections on the Team-Building of High-Level Talent in Shandong Characteristic Industry Town

De-liang Zhang

Abstract Team-building of high-level talent is the core to promote the development of Shandong characteristic town. Based on the status quo analysis on team-building of high-level talent in Shandong characteristic industry town, this paper analyzes the problems existed in team-building of high-level talent in Shandong characteristic industry town, and puts forward with the measures to build up high-level talent team in Shandong characteristic industry town.

Keywords Characteristic industry town · High-level talent · Shandong Province · Team-building

After the State Council brought up with the guideline of "Small Town with Grand Strategy–Taking the Urbanization Road with Chinese Characteristics" in 2000, Shandong Provincial Party Committee and Provincial Government actively responded to the call of State Council and issued a series of policies and supporting measures, leading Shandong characteristic industry town to a stable development road. Till now, the characteristic industrial economy has been the major component of national economy in Shandong Province. Jun-min Wang, the Vice-governor of Shandong Province, put out (2010): "The development of characteristic industry town has important strategical significance on the mode-change, structure-adjustment and the promotion and increase of employment, and there is a large developing room." During the 11th five-year plan, the characteristic industry town in Shandong has relied on the advantageous resources to develop such characteristic industries as food, chemistry, equipment manufacturing, textile, garment and shoes (leather),electronic information and home appliance, construction material, furniture, industrial arts, hardware, plastic, automobile and its fittings, boat and marine engineering, forging, new material, new energy, and pharmacy (Shandong Eco-

D. Zhang (✉)
School of Business, Shandong Polytechnic University, Jinan, China
e-mail: zhangdel@126.com

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nomic and Information Technology Commission 2011). The small and middle enterprises in Shandong Province converged quickly at the characteristic industry town and industrial clusters, forming a batch of well-known regional brands for characteristic industries. There were totally 140 characteristic industry towns being supported with emphasis in Shandong Province. By the end of 2010, there were 71,311 small and middle enterprises gathered in all kinds of characteristic industries in Shandong Province, with 3.75 million employees, fulfilling sales revenue of RMB 1,165 billion Yuan, and taxation of RMB 84.6 billion Yuan.

The high-level talent team in characteristic industry town is the core to push the development of economy with Shandong characteristics, and plays the demonstration and leading role for the building of the entire talent team. On the development of characteristic industry, the high-level talent plays a determinate role. Along with the rapid development of Shandong economy, the demand on high-level talent in characteristic industry town will increase further, but the team-building of high-level talent in Shandong characteristic industry town is laggard, thus both the quantity and the quality of high-level talent at present can't meet the need, which restricts the rapid development of characteristic industry in Shandong. Therefore, it is the basic requirement for the sustainable development of Shandong economy to further cultivate and attract high-level talent applicable for Shandong characteristic industry town.

61.1 The Results Achieved During the Team-Building of High-Level Talent in Shandong Characteristic Industry Town

From the view of the developing course of Shandong characteristic industry town, the high-level talent in characteristic industry town mainly refers to talent in the following areas: The first, senior management in characteristic industry town, including chairman of the board, general manager, and the principal of the party committee and the government, (Zhang 2011) such as the senior management in areas of food development, equipment manufacturing, electronic information and home appliance development, industrial arts development, the process of characteristic products in agriculture, the development of new energy product etc., the Secretary of party committee and the Chief of town. The second, senior technical talent in characteristic industry town, including the professional technician with advanced title of a technical post in characteristic industry; the specialist and academic leader with outstanding contribution to the country and Shandong Province; and the major principal of important projects in the country or Shandong Province. The third, high-skilled talent in characteristic industry town, including the talent with advanced title of a technical post, and the talent with important achievement or creative invention in science and technology area. The fourth, the high-level talent in the development of characteristics products in agriculture, including the talent engaged in the development of characteristics products in agriculture and industrial arts, high-level talent with special skill for the process of agricultural products and the one who may make significant contribution to the development of characteristic economy in agriculture.

In recent years, surrounding the development of characteristic industrial economy, Shandong Provincial Party Committee and Provincial Government has enhanced the team-building of high-level talent in characteristic industry town from three aspects: development, use and attraction. It makes the talent's whole quality in characteristic industry town improve steadily, its structure optimize, and primarily forms high-level talent team with Shandong characteristics and certain scale in characteristic industry town, leading to a new road combining the selection of local high-level talent in characteristic industry town from multichannels with the reasonable introduction of high-level talent into characteristic industry from the out side of Shandong Province.

61.1.1 Construct the Policy System for Team-Building of High-Level Talent in Shandong Characteristic Industry Town

Shandong Provincial Party Committee and Provincial Government consistently paid much attention to human resources work. In order to complete the relevant work, they established the philosophy of "serving the development, talent priority, focusing on use, innovative mechanism, high-end leading and whole development"; comprehensively implemented the strategy of being a strong province by virtue of talent; improved the quality and the whole level of talent; set up the policy systems involving talent cultivation, use, attraction and motivation and other aspects; And issued such files as "Middle- and Long-term Talent Development Program of Shandong Province (2010–2020)", hence determined the direction for the team-building of high-level talent in characteristic industry town. They also founded an incentive mechanism, taking heavy rewards to science and technology, philosophy and social sciences award, special allowance by State Council and special allowance by Shandong provincial government as the orientation, and the independent incentive by each system and each type as the main stream, so as to positively create a good environment and social atmosphere for the introduction, retainment and use of high-level talent.

61.1.2 Manage to Solve the Problem of Unreasonable Structure of High-Level Talent in Characteristic Industry Town, Enhance the Talent Cultivation Force

It is the first task for the development of Shandong characteristic industry town to make the best use of high-level talent, and use it flexibly. In order to solve the problem of unreasonable structure of high-level talent in characteristic industry town, it has carried out the exchange work of high-level talent, and the high-level talent were encouraged to work in basic department, and the front lines of production and research to provide decision-making consultation, science and technology cooperation and technical direction. Each year, the relevant departments selected a group of high-level talent with bright future to exchange, and coordinated and organized the experts group of several academicians and researchers to provide consulting services, advice and suggestions for the harmonious development of the economy and society in Shandong. It also strengthened the work for the high-level talent to serve the development of characteristic industry, adhered to the principles of training and research, focusing on improving the research capacity and innovation capability of high-level talent. It implemented a lot of high-level talent cultivation projects, such as "The Cultivation Plan for Innovative Technology Leading Talent in Shandong Province", "Introducing Thousands of Overseas Innovative and Entrepreneurship Talent" plan, "The Cultivation Project for Excellent Enterprise Manager", "The Project for the Growth of Young Elites in Shandong Province", "The Promotion Plan for Entrepreneurship Talent", "The Development Plan for High-skilled Talent" etc., (Shandong Provincial Party Committee and Provincial Government 2010). Each year, a number of high-level talent were selected to attend various training courses organized by School of CPC and other key institutions for further study, thus preliminarily settled the problems of unreasonable structure of high-level talent in characteristic industry town.

61.1.3 Actively Expand the Channels to Introduce High-Level Talent into Characteristic Industry Town, and Achieve Certain Results in the Work of Gathering Various Talent

Nowadays, Shandong deeply has implemented the concept of scientific development, scientific talent and being a strong province by virtue of talent, insisted on the principle that talent shall obey the administration of CPC, adhered to the law of socialist market and the growth pattern of talent to liberate the thought, to reform and innovate. It should take the team-building of high-level and high-skilled talent as the emphasis; the enhancement of innovation capability as the key; the best use of talent as the root; the mechanism reform and policy innovation as the driving force, so as to attract the talent, stimulate their vigor, improve their performance, forge a area full of high-level talent and excellent labor force, build the brand of "Shandong Talent", and provide substantial personnel and intellectual support for the construction of economic and cultural province. The introduction of overseas talent and intelligence experts has made tremendous progress through the manners of taking a temporary post, engagement, the bidding of science and technology projects, giving lectures, consulting and long-distance diagnosis. There were 39 foreign experts who have won the National Friendship Award, and 27 foreign experts gained Qilu Friendship Award. 82,000 person-times of foreign experts were introduced, 11,000 person-times of people from different fields were trained, more than 870 technologies were introduced, with more than 1,260 varieties of new products. 20,000 overseas students returned to Shandong, bringing in 18 innovative entrepreneurship bases and 38 high-tech business parks (Statistical Yearbook of Shandong Province 2010). Through the measures above, a large number of leading talent have sprung up in areas of food development, machinery and equipment, marine research, biological research, pharmaceutical development etc.

61.1.4 The Total Amount of High-Level Talent in Characteristic Industry Town is Increasing Year by Year, and the Structure of High-Level Talent is Gradually Reasonable

In recent years, through the strengthening the work of training and introduction of high-level talent, the quantity structure of high-level talent has undergone significant changes. By the end of 2011, there were totally more than 4,000 high-level innovative talent in Shandong Province, 38 Academicians, 303 Taishan scholars, 99 at national level, 122 experts with outstanding contributions to the country, 2,800 experts enjoyed State granted allowance, 600 young experts belonged to the Shandong province, 700,000 talent with advanced skills, 380 chief technicians. There are more than 190 doctoral and postdoctoral workstations. With the number of high-level talent increasing, its age structure tends to be more reasonable and younger.

61.2 Problems Existed in the Team-Building of High-Level Talent in Shandong Characteristic Industry Town

61.2.1 The High-Level Talent in Characteristic Industry Town Distributes Unevenly, and its Flow is out of Line

The middle- and long-term problem during the economic development in Shandong is the uneven distribution of high-level talent in different regions and industries. At present, there are more than 350 professional and technical talent per 10,000 people, the number of which ranks 13th in the country, and 797 less than that in Beijing and 132 less than that in Liaoning; there are 15 technicians per 10,000 people; and the amount of scientists and engineers per 10,000 also ranks 13th in the country (Statistical Yearbook of Shandong Province 2010). This does not match with the provincial total population and economic scales in the whole country, indicating that professional technicians are still in desperate need, and the total amount of talent and the talent density should be increased as soon as possible. High-level talent who have specific skills in characteristic industry, who have one kind of skill and multiple capabilities, who are innovative, are particularly in desperate need. From the view of age structure, the age of high-level talent tends to be older, especially those in characteristic industry, most of whom are approaching retirement and centralize in the east. In addition, two-way flow of high-level talent is out of line. From the flow between Shandong and other provinces, it is indicated that inflow outnumbers outflow, with most flowing to the better developed areas, such as Jiangsu, Zhejiang and Guangdong. Most of the talent flowing out are the academic leaders and technical experts in the characteristic industry, while those who flow into Shandong are college graduates. According to incomplete statistics, in recent years, the talent out-flowing from Shandong, are mainly middle-aged young backbones. At the same time, it is difficult to introduce high-level talent needed desperately by Shandong. From the flow within Shandong Province, it is showed that more talent flow from small cities to middle and large cities than that flow in opposite direction, more from the west to the east than that from the east to the west, and more from enterprises to public utility than that from public utility to enterprises.

61.2.2 The Cost to Cultivate High-Level Talent in Characteristic Industry Town is Very High, While the Degree for Marketized Staffing of Human Resources is Very Low

Compared with Zhejiang, Jiangsu and Guangdong, the natural environment in Shandong is much better, while the social environment, living and working conditions are relatively worse. Therefore, it is of great difficult to cultivate high-level talent, and costs much more money and time. Meanwhile, the marketization mechanism of the allocation of high-level talent in Shandong characteristic industry is not fully developed, which is still based on government-driven configuration mode, so the basic role of market in the allocation of human resources in characteristic industry, and the role of human resources in enterprises and public utility cannot give full play.

61.2.3 High-Level Talent have Low Compensation and Bad Working Condition in Characteristic Industry Town

At present, Shandong high-level talent in characteristic industry town are commonly unsatisfied with the working and living environment. Though a series of measures have been taken to improve the compensation and working conditions, such problems cannot be fundamentally solved due to the factors of geographical environment and economic development, especially the problem of low compensation. Therefore, it is difficult to retain high-level talent and introduce new ones. With the economic gap between Eastern and Western parts becoming larger and larger, the gaps in compensation and working conditions are consequently becoming larger as well, which results in high-level talent to flow into the better developed areas.

61.2.4 The Structure of High-Level Talent in Characteristic Industry Town is Too Simple and Lacks of Leading Character

In the team of high-level talent in characteristic industry town, most people's knowledge structure is simple, and most of them prefer theoretical theory, instead of the application of technology. In some characteristic industry towns, there is large gap between the capability of leaders and the need of the position; in others, there is large gap between the capability of senior operating talent and the real demand. From the view of diploma constitution among professional technicians, the number of people with bachelor's degree is smaller, especially those with master's degree or above. From the view of professional structure, excellent talent in characteristic industry are scarce, the academic ladder is not complete, the R&D and conversion capability is low, so there is little research efforts which have important impact both in and out of the country. With the rapid development of characteristic industry, there is an increasing demand of high-level talent, especially those in chemical, equipment manufacturing, textile and apparel and shoes (leather), electronic information and home appliance, materials, ship and ocean engineering equipment, new materials, new energy and pharmacy industry.

61.2.5 The Evaluation System of High-Level Talent in Characteristic Industry Town is not Complete, and the Building Environment of Talent Team Needs to be Optimized

There is no good evaluation system of high-level talent in Shandong characteristic industry town. Current evaluation system is basically based on the diploma and job titles (Wang 2007). On the determination of job titles, the rating standard always highlights the amount of papers and research expenses. In the evaluation of actual ability, it is generally based on the moral quality and the recognition by one's leaders and the fellow colleagues, which lacks scientific and specific evaluation criteria. During the fruit evaluation, it puts emphasis on short-term achievements, and ignores the long-term and systematic research in characteristic industry. On the screen of excellent high-level talent, there is lack of precise talent and performance assessment methods, which seriously affects the scientific and systematical administration on high-level talent. In addition, the growth and development environment of high-level talent in characteristic industry is very bad, where exists the "official orientation consciousness".

61.2.6 The Incentive Mechanism of High-Level Talent in Characteristic Industry Town is not Complete, Which Lacks of the Growing Platform for Talent

Although the level of economic development in Shandong is relatively high, it still puts emphasis on mental stimulation too much when comes to the rewards on high-level talent in characteristic industry town, which can not reflect the talent of the law of demand and the value they contributed. In fact, the material incentives always have been substituted by praise from leaders, reputation incentive and political honor. Even if there is some material incentives, it often is symbolistic, which cannot correctly reflect their real contribution and achievement. This kind of virtualized incentives can't realize the effect of long-term and integrated stimulation, leading to the low activity, less progressive passion and creation, as well as the low working spirit. At the same time, the platform which bears the growth of high-level talent of the Shandong characteristic industry is in shortage and lack of competitive high-tech groups and research institutes with strong competitiveness in the country. Moreover, the amount and scale of key laboratories and experimental base is small, the level is not high, thus there are few significant scientific and technological projects and high-level scientific and technological achievements; the scale of enterprises are small and the technological content in their product is very low. The factors above have led to such a problem that Shandong has insufficient capability to bear and absorb the high-level talent in characteristic industry town.

61.3 Measures to Strengthen the Team-Building of High-Level Talent in Shandong Characteristic Industry Town

61.3.1 Liberate the Thoughts, Establish the Scientific Talent Philosophy, Use New Working Idea to Build the High-Level Talent Team in Characteristic Industry Town

The concept of scientific development needs a scientific talent concept as backup (Shandong Provincial Party Committee and Provincial Government 2010). We should set up a people-oriented concept and an idea that everyone can be a talent. The constraining of degrees, status and professions should be broken up, while morality, knowledge, capacity and working performance should be regarded as a major criteria to measure talent, so that people can be cultivated and developed freely. Work and personality should be respected, and not to blame the imperfect; creativity and success should be respected, while failure should be allowed; choices should be respected so that everyone's values are represented under the guidance of more policies and fewer administration enforcement. Talent as the primary strategic resources should be fully developed, so that a good condition will be formed where everyone can make best use of their capacity. The awareness of reform should be stressed, and the mechanism of developing, attracting and making a good use of high-level talent in the characteristic industry town should be established. Strengthen the marketization of high-level talent and knowledge as capital, and develop and use high-level talent by market-oriented methods.

61.3.2 *Implement the Fiscal and Taxation Policy to Promote the Priority of Talent Investment, and Complete the Mechanism of Team-Building of High-Level Talent in Characteristic Industry*

We should build a multiple talent investment mechanism, which takes the government investment as guideline, the investment of employer as the main body, and the social investment as supplement (Yuan 2008). Government of all levels should take investment in the talent development as priority, ensuring the increases in the expenses in education and science and technology is higher than that of financial revenue. All financial bureaus should actively invest in the implementation of important projects to cultivate and attract talent, the rewarding of talent, and support talent' development. Companies and social organizations should be encouraged to build funds to develop talent. Government should form preferential policy to encourage and support companies which need talent to increase their investment in talent. Social funds should be encouraged to donate for the talent innovation activities.

We also should insist on the principle that talent shall obey the administration of CPC, invent the new methods about the administration, complete the managing mechanism of high-level talent in characteristic industry, which consists of macro control of the government, market allocation, and the self-management of employers, promote the managing function of high-level talent transform to create better developing environment and provide premium public service, and the operation mechanism and administration mode to be standard and in order, public and transparent, convenient and efficient. Perfect the policy system of team-building of high-level talent in characteristic industry, push the cooperation between industry and academy, and cultivate high-level talent in characteristic industry town.

61.3.3 Complete Personnel Educational Training System, Increase Efforts to Train High-Level Talent in Characteristics Industry Town

First, around the advantageous resource exploitation and characteristic industry development in Shandong, the scientific research base and its achievements transformation base should be established (Xu and Shen 2007), which guarantees enterprises and universities cooperate closely, promotes the interaction and integration between high-level talent training in characteristic industry and research cooperation, and establishes the effective mechanism of gathering talent and training talent. And using it as a link, the intelligence flow should be expanded by employing consultants, exchanging lectures, collaborative research and joint development, taking the initiative to attract and support the national research institutes in other provinces, engineering and technology research centers, key laboratories and other research institutions to establish branches in Shandong. A number of projects should be select and applied to our State to be the platform of gathering talent and attracting high-level personnel to realize the effective communication of high-level talent in characteristics industry town. Second, the academic leaders training project should be started-up and implemented. According to Shandong characteristics of economic development needs, relying on the National New Century Millions of Talents Project, an innovative science and technology leading talent development program, the "ten-thousand people plan" of introduction of overseas innovation talents, the Qilu youth growth project and such academic leaders training project to promote the team building for high-level talent in characteristics industry town. Third, around the strategic adjustment of economic structure and dominant industry needs, the subjects and majors in colleges and universities should be adjusted to establish the higher education system adapting to the high-level talent needs in characteristics town. A complete system of high-level personnel training should be formed by further raising school standards and their competitiveness of the universities in Shandong. Fourth, focusing on cultivating high-level management personnel, relying on the well-known enterprises at home and abroad, universities and training institutions, the cultivation of high-level management personnel in characteristics industry town should be strengthened. A management talent pool in characteristics industry town should be established as a part of entire high-level personnel development plan to improve the quality and management level of the high-level talent in characteristics industry town.

61.3.4 Innovate Talent Management System and Improve the Structure of High-Level Talent in Characteristic Industry Town

With the continuous development of characteristics industries in Shandong, the demand for high-level talent has increased. But the existing personnel management system has hindered the development of talent. Therefore the high-level talent management system in characteristics industry town should be reformed to establish a reasonable and orderly high-level talent management system in characteristics industry town (Chen 2011), gradually break down the geographical, sectoral, industrial, urban and rural, identity and ownership restrictions, and streamline the flow channel of talent, in order to promote the high-level talent flow from universities and research institutions to enterprises and the grassroots. The post appointment system should be progressively introduced and the high-level talent appointment mechanism which guarantees talent promoting and demoting, getting in or out should be established. The high-level talent structure in characteristics industry town should be adjusted accordingly in the general laws of the high-level talent growth, using young talents boldly. In the industries of food, chemistry, equipment manufacturing, textile, garment and shoes (leather), electronic information and home appliance, construction material, furniture, industrial arts, hardware, plastic, automobile and its fittings, boat and marine engineering, forging, new material, new energy, and pharmacy, the intelligence and experience advantages of the old scientists should be taken, letting them be the good mentor and fully exploiting the potential of high-level talent.

61.3.5 Deepen the Competition and Incentive Mechanisms that are Conducive to the High-Level Talent in Characteristic Industry Town to Come into Force

Scientific and social talent evaluation and found system should be established based on the post duty, oriented by integrity, ability and performance (Lu 2007). To improve talent evaluation criteria, we should overcome the tendency of academic credentials only and papers only, not expect talent to be perfect, evaluate talent based on their performance and contribution, and adhere to cultivate talent in practice and motivate them to do pioneering work. Therefore, the strategies of improving the high-level talent income distribution system in characteristic industry town are as follows: Firstly, an allocating incentive mechanism should be established which takes the performance appraisal as the core, fully reflects the value of talent and encourages talent innovation. This mechanism should consider the features of high-level talent of Shandong characteristics industry town, adapt the market economic system, closely link with job performance, and encourage innovation and R&D of high-level talent in characteristics industry town. The allocation policy of that high-level talent in characteristics industry town participated by technology and scientific research should be made, which gives the stock right and share options incentive to the high-level talent who have made outstanding contributions in scientific research and commercialization, and give the tax preference on scientific research achievements transformation. The policy should encourage and regulate the professional and technical personnel to take part-time job and get according salary. Secondly, the incentive mechanism of high-level talent in characteristics town should be improved. The allocating policy should be in operation, which guarantees that the payment of high-level talent is in accordant with their job, and that the first-class talent, first-class performance and first-class scientific research gains the first-class compensation. Thirdly, the high-level talent compensation system in characteristics town should be established, which adheres to the principle of combining the spiritual rewards with material incentives, improves the talent reward system which is oriented by government incentive and is leaded by employer and social forces.

61.3.6 Update the Standards and Content of the Personnel Evaluation, and Improve the Evaluation Mechanism of High-Level Talent in Characteristic Industry Town

It is important to establish the new evaluation mechanism of high-level talent in characteristic industry town. In the evaluation standard, this evaluation mechanism should adhere to the principle of combining qualitative and quantitative evaluation criteria, change evaluating the degree and the position of high-level talent in characteristic industry town to evaluating their creative job and its results, and establish a set of scientific, accurate, objective, comprehensive evaluation index and parameter system which can embody the characteristics of different types of talent (Ma and Li 2011). In the way of the evaluation, this mechanism should change to emphasis on research capacity assessment, take the performance evaluation of the key point, establish the recommendation system, the tenure target responsibility system, assessment system and personnel oversight accountability system which takes of knowledge, ability, professional, professionalism as the main elements, and establishes and improves the special evaluation method of the high-level talent in characteristic industry town, especially emphasizing on the acknowledgement of the experts. In the evaluation content, this mechanism should base on the scientific research capacity and its results, focus on the actual contribution and the role of the high-level talents, take the potential development but the qualifications and positions as the standard, and evaluate talents objectively, fairly and equitably. To innovate the evaluation mechanism of high-level talent in characteristic industry town, we must explore and evaluate the criteria, methods and means of evaluation the high-level talent, and refine the specific requirements of high-level talent in the knowledge, ability and performance in accordance with the principles of category management.

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Chapter 62
Study on the Model of Coal Industry Cycle Economic Development and Evaluation System

Bo Wang, Wei Jiang, Ji-hui Zhang and Cheng-xia Wu

Abstract Firstly, the development status and existing problems of China's coal industry is analyzed. Then, the circular economy development model is introduced. In order to achieve the rationalization of coal exploration and use, the circular economy and coal industry are combined to explore the model of coal industry cycle economic development. Finally, the evaluation system of the coal industry is constructed providing theoretical support for the development of the coal industry.

Keywords Coal industry · Cycle economic · Development model · Evaluation system

62.1 Introduction

With the rapid economic development in China, energy demand is growing. The coal is basic energy in China and coal consumption accounts for two-thirds of primary energy consumption. However, the primary energy consumption structure is dominated by coal, which brought the increasing pressure to the environment. In facing of the dual pressures of growth in energy demand and environmental protection, this brings question on how to ensure energy supply and security. It also raises issue about how to abandon the traditional model of development to promote the coal industry economic and environmental coordinated development are the key to achieving sustainable development.

B. Wang · W. Jiang · J. Zhang (✉)
School of Management, Tianjin University, Tianjin, China
e-mail: zhangjihui@tju.edu.cn

C. Wu
School of Management, Tianjin University of Technology, Tianjin, China

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62.2 The Development Status of Coal Industry

The energy production and consumption is huge in China. There are rich in coal and oil, but poor in less gas. The proportion of coal in primary energy production and consumption has remained at more than 70 %. The 76 % of electricity fuel, the 70 % of steel energy, the 80 % of the civilian fuel and the 60 % of the chemical fuel are all from coal. Compared with other coal resources in the country, the situation of the coal resources in China is abundance in the total coal resources, but reserves are less certain exploration depth. The coal useful life in China is approximately 90–100 years, according to the direct use of coal resources and the annual output of 2 billion tons of coal (Li 2001). At the same time, due to the unreasonable development and utilization of coal industry in China, there are still many problems unsolved.

1. Resource recovery rate is low. The process of coal mining and using the waste is appalling. At present, the national coal mines resource recovery rate of is only bout 40 percent. In particular, the recovery rate of small-scale coal mines is only about 30 %. At the same time, the recovery rate of coal mines in the developed countries is high, about 80 % of the same period.
2. Environmental pollution is serious. Increasing environmental pressures brought by the coal-based energy consumption structure. A lot of environmental problems are coming in the process of coal mining, such as exhaust gas, sewage and waste residue.
3. The waste of water resources is serious. Coal mining had caused the waste of water resources, which also exacerbated the scarcity of water. According to the statistics, every year the coal discharge mine water 2.2 billion cubic meters, while the use rate of which is less than 40 %. Surface subsidence caused by coal formation makes the water body dry up, affecting the regional ecological environment (Song 2008).
4. The ecology lost imbalance. The surrounding environment of the coal enterprises is lost ecological imbalance,which mainly due to the exploitation of coal mines. Powerful underground mining had led to the collapse of the surface. According to preliminary statistics, the large area of mining subsidence in the country has come to 1,150 km^2 (Wang and Liu 2010).

62.3 The Connotation of Circular Economy

62.3.1 The Meaning of the Circular Economy

Circular economy is based on the efficient use and recycling use of resources, with characteristics of low consumption, low emission and high efficiency. It in line with the concept of sustainable development model, which changed the traditional development as a signal of mass production, mass consumption and a large number of abandoned waste (Sun 2007). The "3R" principles—reduction, reuse, and recycling of materials and energy—are often cited to describe the principle of circular economy. This definition not only points out the core of the circular economy, the principles and the characteristics, and also points out the circular economy is in line with the concept of sustainable development, capturing the crux of relative shortage of resources and a large number of consumption.

62.3.2 The Operation Mode of Circular Economy

After years of studies, a unique recycling economy development model has formed, namely minor circulation, medium circulation, greater circulation, super-cycle, waste disposal and recycling industry.

62.3.2.1 Minor Circulation

At the enterprise level, the typical businesses and large enterprises is chosen, through product eco-design, eco-efficiency concept and cleaner production measures construct the eco-industrial pilot of a single enterprise and reduce material and energy use in products and services, in order to achieve the pollutant emissions minimized.

62.3.2.2 Medium Circulation

At the regional level, in accordance with the principles of industrial ecology, the enterprises develop a symbiotic relationship and establish the industrial ecological park, by way of material integration, energy integration and information integration between the enterprises.

62.3.2.3 Greater Circulation

At the community level, we should focus on the establishment of recycling-oriented cities and provinces. In recent years, the State Environmental Protection Administration establish circular economy test pilot in the country and build a new industrial pattern. We also should set up waste resources industry about processing, disposal and recycling. So, the fundamental solution to the utilization of waste resources in the society is come true (Shengdao 2005). The greater circulation promotes green consumption at the community level and builds waste separation recovery system, focusing on the material circulation and energy cascade utilization between the three industries. Finally, we can establish a recycling-oriented society (Zhou 2006).

62.4 Research on the Model of Coal Industry Cycle Economic Development

According to the characteristics of the coal industry product life cycle phases, the recycling economy development model is divided into: the coal resources exploration model, the coal resources development model, the coal resources comprehensive utilization model, in addition to eco-parks, that is, cycles and small cycles. This paper describes the first three modes.

62.4.1 Mode of Circular Economy in Prospecting Coal Resources

Coal resources exploration means the exploration of coal resources (this does not explain anything, try rephrasing). In accordance with the business ideas, namely more with less output, we should also do minerals development, utilization and improve the economic and social benefits of the coal enterprises, such as methane, metal ores and non-metallic mineral resources. The cycle of economic model of coal resources exploration is change the traditional model that relies on geological resource exploration into a new model that relying on geological resources exploration (Meitian 2007).

It is an exploration of the efficient use, recycling and reduction, with the character of low cost, efficiency and effectiveness, in line with the concept of sustainable development model of economic growth. Coal resources exploration cycle economic model shown in Fig. 62.1.

62.4.2 Mode of Coal Resources Circular Economy Development (Clean Extraction)

Clean mining is based on coal mining. It goes through the construction methods, the processes of coal mining and related technologies to strengthen the exploration of hard-to-mined coal. During the mining process, reduce the discharge of waste as possible and the exploitation caused by ecological and environmental damage (Fig. 62.2) (Jiang et al. 2007).

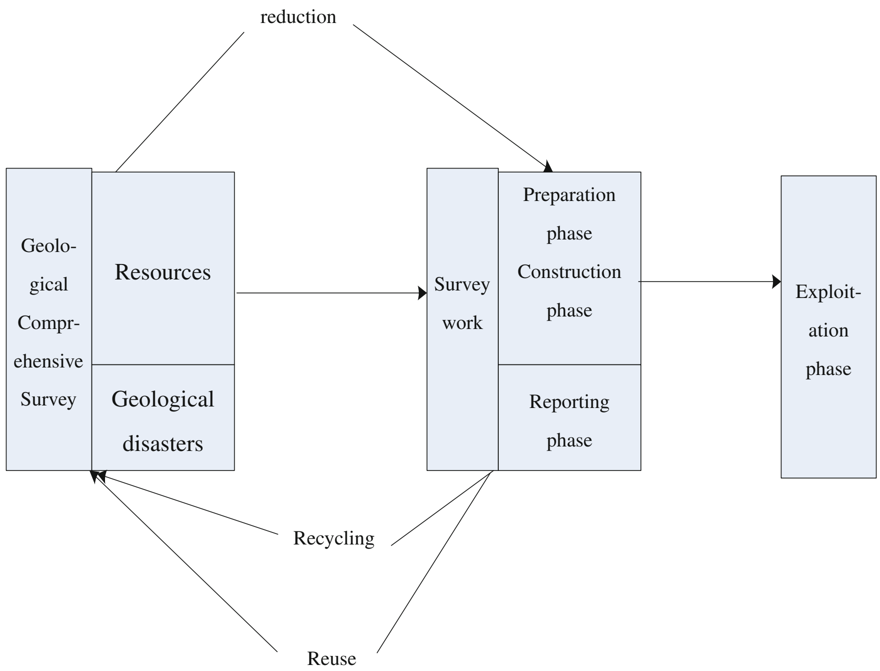

Fig. 62.1 Mode of coal exploration circular economy

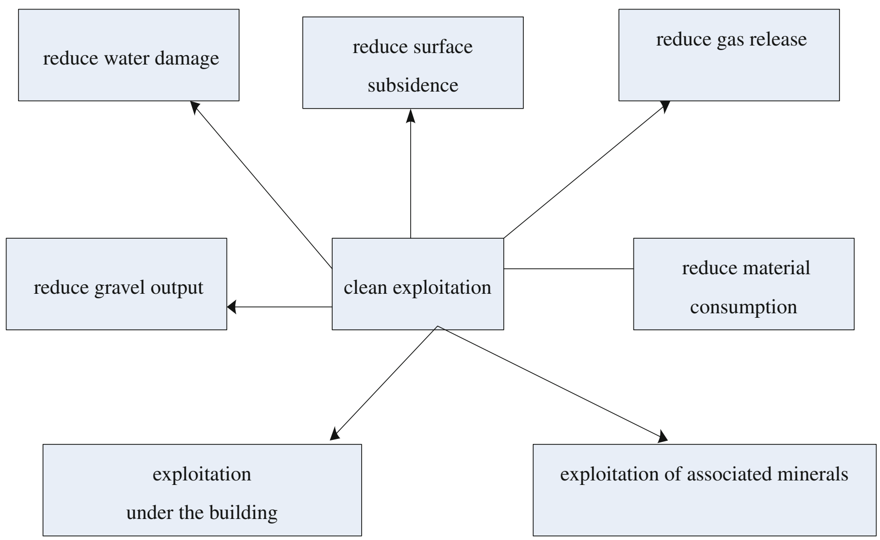

Fig. 62.2 The main content of the clean mining

62.4.3 Comprehensive Utilization of Coal Resources Circular Economy Mode (Clean Coal Technology)

Clean coal technology refers to reduce pollution and improve the use efficiency of processing in the process of exploration and utilization, in order to maximize the potential use of coal, as well as keep pollution in the lowest level. Clean coal technology (Clean Coal Technology) is first proposed in the United States in 1985 for the economic development and environmental protection. A national clean coal technology demonstration programs was also made. Comprehensive utilization of coal resources, the cycle of economic model shown in Fig. 62.3.

62.5 The Evaluation System

In accordance with the basic principles of the 3R, scientific, systematic and operability as cycle economic indicators, combined with the status quo and development capabilities and the inherent potential of the development of circular economy in China's coal mines, the coal business cycle model of economic development must be able to help coal mines.

In the closed-circuit processing, material storage and energy management should bring ecological, economic and social benefits, achieving sustainable development (Sun 2005). Coal industry development of circular economy evaluation index system is shown in Table 62.1.

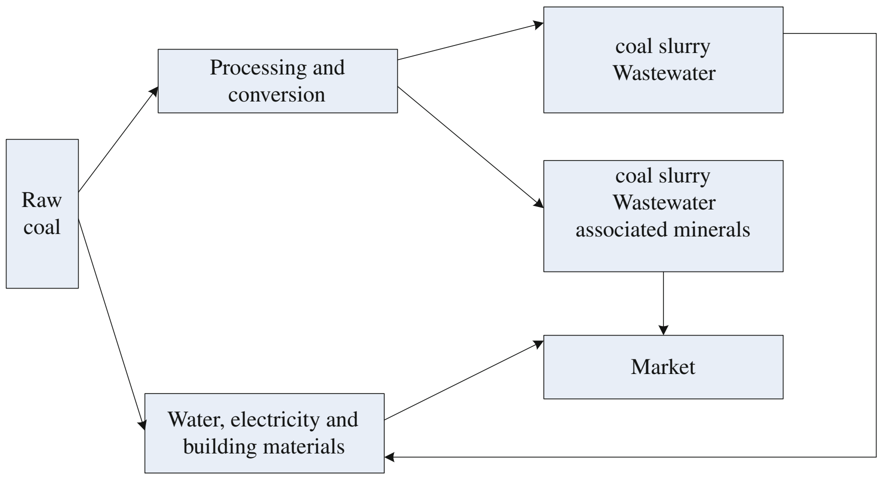

Fig. 62.3 Comprehensive utilization of coal resources circular economy mode

Table 62.1 The coal industry evaluation index system

The indicators of cyclic economy	The indicators of resource development and utilization	Reserve-production ratio
		The extraction rate
		Raw coal rate
	The indicators of resource consumption	Ten thousand output value energy consumption
		Ten thousand output value water consumption
	The indicators of pollution emissions	Ten thousand output value solid waste emissions
		Ten thousand output value water waste emissions
		Ten thousand output value gas waste emissions
	The indicators of pollution reduction	Solid waste disposal rate
		Wastewater discharge standards rate
		Rate of waste gas treatment
		Rate of smoke and dust control
	The indicators of comprehensive utilization	Material recycling rate
		Comprehensive utilization of water resources
The indicators of economy	The indicators of economic development level	Ratio of assets
		Cost margin
		Per capita GDP
	The indicators of economic quality development	The proportion of non-coal output value
		The proportion of investment in research
		Per capita income
		Mortality rate

62.6 Conclusion

The coal industry circular economy development is based on production and consumption in China. In the process of consumption savings and waste reduction, resource reuse and the "zero discharge" are to promote the simultaneous growth of the coal industry economic efficiency, social and ecological benefits. The promotion of recycling economy development model is the key to the rational development of the coal industry, which related to the sustainable economic development, resource exploration and comprehensive utilization. We build a relatively reasonable evaluation index system, in order to effectively guide the sustained rapid and healthy development of coal industry.

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Chapter 63
Analysis of Technological Innovation Capability of Equipment Manufacturing Industry in the Early Days of the Development Drive of Western China

Yang Yang, De-gang Yi and Chang-hui Xu

Abstract The development drive of western China opens a new picture for western development. But compared with eastern and central-eastern China, its development of the equipment manufacturing industry lags behind after the inception of reform and opening up due to its economic background and slow absorption and digestion of advanced overseas technologies. The thesis expounds the technological innovation capability of equipment manufacturing industry in western China from the perspective of historical development and reaches the conclusion that the only right way to improve development of technology innovation capability of western equipment manufacturing industry which focuses on national defense science and technology industry and major technological equipment is implementing the introduction and upgrading of technology under the general principle of sticking to independent innovation and reducing unnecessary administrative intervention.

Keywords Technological innovation capability · Equipment manufacturing · "Exchange market for technology" · Western China

Founding:(1) China Soft Science: 2011GXQ4D036, Compare to Inner Mongolia Emerging Industry Competitiveness, 2011.9–2014.9.
(2) Inner Mongolia Soft Science: 113306, Study on Technology Innovation of Inner Mongolia Enterprise Basing on CTI and Roadmapping. 2011.10–2012.1.

Y. Yang (✉) · C. Xu
Chaint Robotics Co., Ltd, Changsha, China
e-mail: yangedward@139.com

C. Xu
e-mail: 13488700261@139.com

D. Yi
Institute of History for Science and Technology, Inner Mongolia Normal University, Inner Mongolia, China
e-mail: yidegang@yahoo.com.cn

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63.1 Introduction

The development drive of western China is an important policy of the central government with a purpose of "utilizing surplus economic development capacity in the eastern coastal regions in improving economic and social development level of the western regions and consolidating national defense". In January 2000, the State Council established a leadership team for western region development. As the core component of manufacturing industry, equipment manufacturing industry is the foundation of national economic development especially industrial development. The western regions are important traditional industrial bases, which have made significant contribution to the development of western regions and national defense and security with their equipment manufacturing industry. Prior to the 1970s, the western regions were emerging equipment manufacturing bases in China with apparent advantages such as high starting point of technology, rapid development speed and uniqueness. However, after the reform and opening-up from 1978, with advantages in aspects such as location, idea and management, the coastal regions pioneered in getting in line with international practice, with their equipment manufacturing industry growing rapidly on a higher starting point.

Comparatively, the development of equipment manufacturing industry of western China is slow and its original superiority has been weakening gradually. Thanks to long-term national support, the equipment manufacturing industry of western China is gaining solid foundation and strong technical force. Therefore, it is urgent to make research on the issues as to what its technological innovation capability lies and how to bring this capability into more effective play to achieve better development.

63.2 Findings

63.2.1 Economic Background for the Development of the Equipment Manufacturing Industry of Western China After the Inception of Reform and Opening up

Since the inception of reform and opening up, the focus of national investment has shifted and the market economy has developed, leading to increasingly prominent contradictions in the traditional organization and structure of the equipment manufacturing industry of western China, as reflected in problems such as a low level of marketization, inadequate business vitality of companies, excessively high proportion of state-owned economy, gradual ageing of some sectors, products, equipment and technology, brain drain, high liabilities of companies, heavy social burdens and great pressure of social security. As the mainstay of the equipment manufacturing industry of western China, the defense science and technology industry is restrained by soft and hard factors, e.g. the industrial structure and policy environment as well as other factors, including weak awareness of companies for technological innovations (Yanmou 2007). In the meantime, since 1970s, microelectronic technology represented by large-scale integrated circuit and microelectronic computers has grown by leaps and bounds so that it has found rapid application in the equipment manufacturing industry, thereby facilitating the mutual promotion and tight coupling between mechanical industry and electronic industry. The international equipment manufacturing industry has begun to enter the development stage characterized by reorganization and structural upgrading through continuous technological innovation. Compared with the eastern regions, the western regions of China are obviously backward (Chao 2007).

63.2.2 Technology Introduction and Absorption by the Equipment Manufacturing Industry of Western China: Comparison With Central–Eastern China and Analysis

In modern times, China has relied primarily on technology introduction for its technological development. In the first decade after its founding, the New China quickly laid its own industrial foundation mainly by introducing the technology of the Soviet Union, achieving marked results; in 1960s, the effects of domestic political environment caused a nosedive of both quantity and quality of the projects using introduced technology in New China; in 1970s, China gradually opened the door to the outside world, leading to a leapfrog development of technology introduction efforts; 1980s was the peak time of technology introduction in China (Degang 2007). Therefore, Zhang Baichun and other scholars noted that "The development journey of modern technology in China is a progress history of localized foreign technology rather than an invention history. (Zhang 2004)" This conclusion is even more appropriate if reviewed from the perspective of the development journey of the equipment manufacturing industry of western China.

At the beginning of reform and opening up, the manufacturing industry in the western regions, as opposed to its eastern counterpart, was plagued by a variety of problems, such as lower industrial aggregate, low level of technological development and low labor productivity. According to statistics, in 1981, China had a total of 381,500 industrial enterprises, with 43 % of them being distributed in the 7 provinces and municipalities in coastal regions and merely 11.1 % in the 9 frontier provinces (autonomous regions). Additionally, if the average overall labor productivity of national industrial enterprises in 1981 was 100, then it was the highest in Shanghai, reaching 228.3, compared with Tibet, Guizhou, Qinghai,

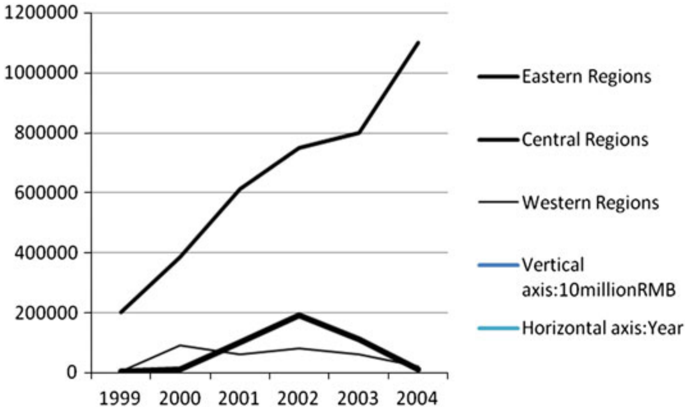

Fig. 63.1 Region-specific comparison of spending on technology introduction in major years

Ningxia and Inner Mongolia, which were 46.9, 54.2, 55.9, 56.1 and 56.3, respectively (Luo 1986). The existence of the above differences has decided that, after the inception of reform and opening up, special attention should be paid to technology introduction in the development of western China. By comparing the western regions with the eastern and central regions in terms of the spending on the digestion and absorption of technology, technology introduction and technology transformation in 1999–2004 (Figs. 63.1, 63.2, 63.3), the researcher can see that the western regions fell far behind the eastern regions and were basically on a par with the central regions. It also reflects that the eastern regions are far ahead of the central and western regions in terms of the introduction, transformation, digestion and absorption of high technologies (Deng 1989).

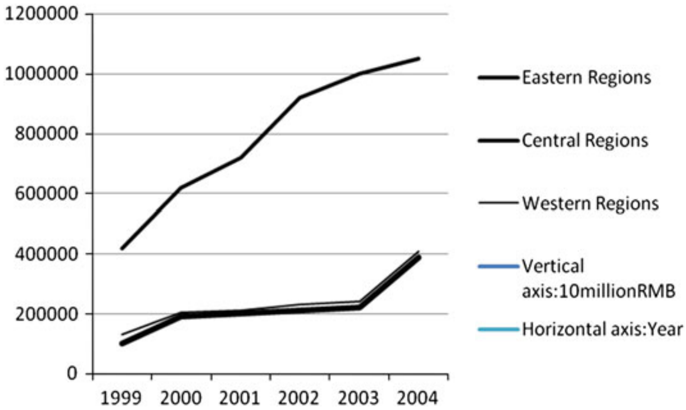

Fig. 63.2 Region-specific comparison of spending on technology transformation in major years

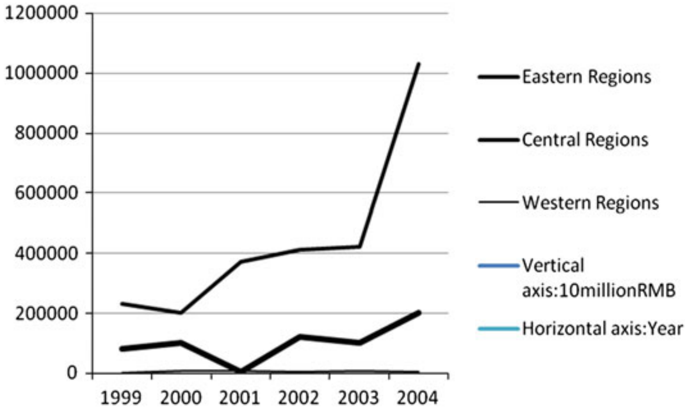

Fig. 63.3 Region-specific comparison of spending on technology digestion and absorption in major years. *Source of data* Statistical yearbook of High-tech Industry of China (2005)

63.2.3 Evaluation of the Technological Innovation Capability of the Equipment Manufacturing Industry in Western Provinces

Regional innovation capability is a key factor that decides the competitiveness of a country or region. There is a need to evaluate the technological innovation capability of the equipment manufacturing industry in the western provinces (autonomous regions)., While the measurement of technological innovation capability is particularly important for the sustainable development of an innovative organization, for such organization knows better about its own advantages, disadvantages and competition status through correct and appropriate measurement so as to secure a favorable competition status by formulating or adjusting the relevant strategy (Liu 1993). Therefore, the establishment of a good system of evaluation indexes is conducive to the measurement of technological innovation capability.

Since the equipment manufacturing industry is the principal part of the industry in western China, its technological innovation capability represents to a great extent the industrial technological innovation capability of western China. Out of the considerations given to the selection of data, the index system for evaluation of the innovation capability of the equipment manufacturing industry in western China has been based on an analysis of the connotations and structure of regional industrial technological innovation capability. The technological innovation capability is divided into 10 indexes, including: R&D investment intensity (x1), proportion of R&D personnel (x2), proportion of scientists and engineers (x3), R&D funds (x4), investment intensity of funds for science and technology (x5), number of patents owned (x6), number of R&D institutions (x7), sales proportion of new products (x8), output value rate of new products (x9), labor productivity of new products (xl0), which is based on the investment capability, R&D capability and output capability of industrial innovation activities, according to the principle of operability and data accessibility and the established evaluation system at home and abroad, and with a reference to the existing evaluation system worldwide.

According to the data included in the Statistical Yearbook of Science and Technology of China (2006) and Statistical Yearbook of China (2006) and the data officially released by the Ministry of Science and Technology, the technological innovation capability of the equipment manufacturing industry in the western provinces has been preliminarily measured, calculated and then evaluated. Since the data of Tibet were unavailable, only the data of the other 11 provinces were involved.

Firstly, SPSS13.0[1] was used for standardized processing of the primary data to eliminate the influence of different dimensions. As can be learned from the matrixes created by the software, there is a strong correlation between the indexes, which permits factor analysis. Then, principal component analysis (PCA) method is used for analysis under the principle that the characteristic value is greater than 1. Based on an accumulative contribution rate above 85 %, two factors have been extracted.

The first principal component Zl, which is called the input–output factor, is correlated with the indexes of xl, x2, x4, x5, x6, x7, x8 and x9. The second principal component Z2, which is called the human resources factor, is correlated with the indexes of x3 and xl0. As the above information does not support judgment of the innovation advantages and disadvantages of the western provinces in their industrial development, it is necessary to compute the scores obtained by the provinces in terms of the first and second principal components and the comprehensive innovation capability. The coefficient matrix of common factor scores generated by the SPSS10.0 software was used to compute the factors and the comprehensive scores. The results have been shown in Table 63.1.

From the above computed results, it can be seen that, in terms of input and output, Sichuan, Chongqing and Shaanxi are on the upper end of the scale, while Qinghai and Xinjiang on the lower end, with other provinces in the middle. In terms of human resources, Chongqing remains on the top and is followed immediately by Xinjiang and Guangxi, which have achieved marked results in the development of human resources. The ranking of Shaanxi Province under this factor was affected by factors such as the low level of industrialization and urbanization, the concentration of scientific and technological personnel in central cities led by Xi'an, the weak scientific and technological foundation in the broad rural areas and insufficient investment in technical personnel. Because of the great weight of the input–output factor, the ranking of the comprehensive innovation

[1] SPSS is the abbreviation of Statistical Package for the Social Science, which is an application software developed by SPSS Inc. for integrated computer data processing. After some 30 years of development, it has become one of the most popular statistical software packages in the world now. Used in the evaluation of regional comprehensive strength, SPSS has improved the efficiency and accuracy of evaluation to a great extent.

Table 63.1 Ranking of comprehensive innovation capability of western provinces

Province (Autonomous region)	Ranking of input–output factor	Ranking of human resources factor	Ranking of comprehensive innovation capability factor
Sichuan	1	11	1
Chongqing	2	1	2
Shaanxi	3	9	3
Guangxi	4	3	4
Inner Mongolia	6	4	5
Guizhou	5	7	6
Gansu	7	5	7
Ningxia	8	6	8
Yunnan	9	10	9
Qinghai	10	8	10
Xinjiang	11	2	11

capability factor for these provinces was close to that of input–output factor. As can be seen, in these regions, the comprehensive input–output situation of high technology is the most important index that influences comprehensive innovation capability. The innovation capability (including potentials) of the equipment manufacturing industry of Sichuan, Chongqing and Shaanxi is the strongest in the western provinces. This dovetails with the construction investment made by the government in these provinces for the development of the equipment manufacturing industry in different historical periods.

63.2.4 Rethinking the Policy of "Exchange Market for Technology"

At the end of 1970s, in order to cope with the "double-shortage model" characterized by lack of capital and technology in domestic economy, China opened the door to foreign countries and started to utilize foreign capital. At the beginning of the policy of foreign capital absorption, the companies in China focused on capital injection in the form of fund. However, it was difficult to narrow the gap between China and developed countries in industrial technologies by only relying on attracting foreign capital. Thus factors led to the foreign companies contributed capital and technology, while the Chinese party became a shareholder mainly by converting plants into cash, which was the major form of capital injection for both JV parties at that time.

Affected by this, introduction of foreign capital of Chinese companies gradually switched from demand of capital to demand of technology, and positioned fundamental starting points at introducing advanced technologies and management methods of foreign countries. Following this thought, in *National Industry Policy*

Guideline in the 1990s, it is clearly pointed out that, it is allowed to open up part of domestic market conditionally. Its main purpose is to enhance internal content of national economy with foreign capital, i.e., to expand market opening continuously, attract more foreign merchants to invest in China and introduce more advanced technologies. This was the background of the strategy of "exchange market for technology" (State Council 1994). The purpose was to exchange for the leap of overall technology level of China through market opening and technology introduction. After that, the growth of total economic output and continuous expansion of foreign trade in China verified the effectiveness of this strategy to some extent. However, it should be seen that, the negative impact of the policy of "exchange market for technology" is also apparent (Li 2006).

Firstly, China takes no initiative in market or technology whatsoever. It can be seen from practices of these years that, all Sino-foreign JV companies on which China government placed large hope have given up R&D institutions in China, only regarding Chinese party as a manufacturing and production base and a bridge to communicate with the government, which have made the hope of enhancing technology level of Chinese party vague. Investment of foreign merchants in China did not bring positive impact at all, although substantial self-owned brands have been given up to open up domestic market. The technology transfer of foreign companies is a kind of marginal technological diffusion, which means foreign companies can force the Chinese companies to quit through establishing a JV company first and then incurring losses.

In the beginning years of 21st Century, there has been a trend of being acquired or controlled by foreign companies in the top companies of western equipment manufacturing industry with continuous entering of foreign capital., as Ningxia Xibei Bearing Co., Ltd had cooperated in 2001 then had been delivered the remaining 49 % of stock ownership to the German company for the sake of the capital introduction interest of government (Wu 2007).

Secondly, there are inherent logical flaws in the concept of "exchange market for technology". The key flaw lies in the following fact: technology is a dynamic concept, which means that grasping a technology is not equal to having technology development capability, and new technology today is not equal to new technology tomorrow. In the light of residual claim of technology, both the technology owned by transnational companies and the technology owned by local companies have huge impact on the national welfare of a country. Without consideration of the issue of residual claim and from the static point of view to regard the concept of "exchange market for technology", the entry of transnational companies will bring new technology undoubtedly. However, if the issue of technology innovation is taken into account, there will be a logical fault in terms of stock technology and technology innovation, i.e., the strategy of "exchange market for technology" is expected to exchange for improvement of technology innovation capability of local companies through transferring market, which proves this strategy is logically invalid.

Thirdly, technology of China is increasingly depending on foreign countries. According to statistics, in three-capital companies in China, the average R&D

expense only accounts for a proportion of 0.4 % of sales revenue, of which joint capital is 0.08 %, foreign capital is 0.03 % (Wang 2004). Facts illustrate that, if the policy of "exchange market for technology" continues, the gap of technology level with developed countries would not be narrowed, and the long-term increase of economic aggregate of China cannot be realized even though there is short-term increase of GDP, for the profits of many products with brand of "Made in China" are taken away by foreign companies.

Furthermore, if the strategy of "exchange market for technology" is one-sidedly implemented, reduplicative and blind introduction will be easily brought about due to the absence of macro control. In the 1980s, for instance, many companies in western provinces and cities, including Jiangxi, Chongqing, Liuzhou etc., suffered tremendous waste of finance and resources after introducing automobile manufacturing technology from Isuzu of Japan. According to historical experiences, only by utilizing foreign investment as well as getting rid of technology dependences on foreign countries, can equipment manufacturing industry in western China develop stably and rapidly. Real core technologies and core equipments cannot be exchanged with "market". Western equipment manufacturing industry which focuses on national defense science and technology and significant technology equipments needs to have continuous independent innovation capability even more because it relates to the national safety.

63.3 Summary

The last phase of 20th century was a period of adjustment and reform for western equipment manufacturing industry. In this period, western equipment manufacturing companies adopted a development approach of technological innovation with absorption of foreign capital and technology in order to cope with the situation of deficient capital and backward technology. However, compared with the middle and eastern regions of China, the western regions of China still lagged behind a lot with respect to the strength of capital introduction and achievement of technology introduction and transformation. In particular, the adoption of the strategy of "exchange market for technology" caused a series of negative impacts, which affected the development of industry and hampered independent innovation of western equipment manufacturing industry.

Hence, it can be seen from the perspective of historical development that, the only right way to improve development of technology innovation capability of western equipment manufacturing industry which focuses on national defense science and technology industry and major technological equipment is implementing the introduction and upgrading of technology under the general principle of sticking to independent innovation and reducing unnecessary administrative intervention.

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Chapter 64
Analysis on the System Dynamics for Formation Mechanism of Independent Innovation Capability in Large-Scale Projects

Min Li, Jin Zhou and Jun Gao

Abstract The large-scale project is a bridge of science and technology, and is an important platform for independent innovation about national key technologies. Factors that affect independent innovation capability are various and complex. We obtain the influence element of innovation incentive by combining the literature, then build dynamic system model of independent innovation in large-scale projects. The model reveals formation mechanism of independent innovation capability in large-scale projects.

Keywords Large-scale projects · Independent innovation · System dynamics · Causal diagram

64.1 Introduction

Developing countries rely on "Technology Catch-up" to promote the international competence. Feng (2000) considered that independent technological innovation is an effective means to enhance absolute and relative position of the international division of labor for developing countries. Although the models of independent innovation include re-innovation after digestion about imported technology, integrated innovation, original innovation and the others (Yong 2005), the core is to cultivate independent innovation capability of local Enterprises (Fan 2006).

Due to uncertainty, complexity, time pressure and customization in large-scale projects, the main participations are always lack of adequate technical reserves to meet the construction requirements. So the managers of large-scale projects have to go through technology innovation to meet this challenge. The construction of

M. Li (✉) · J. Zhou · J. Gao
School of Management and Engineering, Nanjing University, Nanjing, China
e-mail: sunrisemin@gmail.com

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large-scale projects can directly lead various technical modules embedded in the projects to apply to the other sectors and areas, which will cause technology upgrade for the whole related industry chain, and then promote the country's competitive capacity (Heighes 1997; Zhaohan et al. 2009).

Therefore, the large-scale projects have become important carriers and incubators for innovation of science and technology, and the main battlefield of engineering technology innovation, and the basic platform for enhancing national independent innovation capability.

First of all, this paper offers systematic analysis of factors and their system structure about independent innovation capability in large-scale projects. Secondly, the paper analyzes the basic process of the formation and accumulation about independent innovation capability of large-scale projects based on causal diagrams of the system dynamics (System Dynamics). Finally the paper gives some suggestions about how to cultivate independent innovation capability in large-scale engineering projects.

64.2 System Constitutes of Independent Innovation Capability in Large-Scale Projects

64.2.1 The Content of Independent Innovation Capability in Large-Scale Projects

To understand independent innovation capability of large-scale projects, we must define three basic concepts: the characteristic of engineering technology innovation, content of independent innovation and innovation capability in large-scale projects.

Large-scale projects are complex innovative products, which involve process innovation, product innovation, and material innovation. Therefore, different from the traditional linear process, such as "R&D-Manufacturing-Marketing", innovation process of large-scale projects is an integration process of strategy, functions, technology and project in the network environment (Yansong 2008). Shen et al. (2009) pointed out that technology innovation of large-scale projects is an activity that the innovation units re-combine the resources by applying certain technology in an open competitive environment in order to meet the technical requirements of large-scale engineering projects. Also, it is the collaborative innovation integrated into national strategy with high degree of user participation, and is a multi-technology group innovation.

Since the national science and technology development is a major strategic mission of large-scale projects, comprehension of independent innovation seems to be narrow if just limited to a single enterprise unit. Shi (1996) indicated that innovation can be characterized in two levels, corporation and nation, and referred to the country (company) obtain some valuable research results dependent on its own efforts, not on other countries (other companies). Wu (2005) considered that independent innovation actually is the national autonomy, which is on behalf of the interests of the whole country. This paper argues that independent innovation of large-scale projects is reflected in the independent R&D of core modules and the independent construction integration of project.

In 1990, China's National Science and Technology Commission formulated the "Outline of technological innovation projects", which defined that technological innovation capability include innovation decision-making capability, R&D capability, engineering capability, manufacturing capability, marketing capability, organizational management capability and resources configuration capability etc., (Liu 2008). The capability of complex product systems can be divided into functions, strategic and project capabilities (Davies 1997).

As discussed above, this paper proposes that independent innovation of large-scale projects is ultimately reflected on the ability of independent research in the limited time, and on the promotion of independent innovation motion and R&D success rate.

64.2.2 The System Elements of Independent Innovation Capability in Large-Scale Projects

As mentioned above, this paper considers that independent innovation capability in large-scale projects consist of three parts, such as innovation decision-making capacity, R&D capacity and engineering organizational capacity. In addition, formation and growth of independent innovation capability in large-scale projects will be affected by policy environmental factors, engineering factors, technical factors and organization and coordination factors (see Fig. 64.1).

Hekkert et al. (2007) concluded that the attitude and motion of senior management about innovation are primary factors that affect innovation motivation and performance. In this paper, the innovation decision-making capacity refers to decision-making motivation and innovation-model selection ability of independent innovation that will be enhanced with awareness of independent innovation increasing. And the R&D capability is fundamental to the success of technological innovation; the engineering organizational capability is characteristic to the engineering innovation motivation, which includes project organization and coordination of resources for innovation.

The awareness of independent innovation will be significantly impacted by policy environment. Wang and Wang (2005) concluded the policy environment factors that affect independent innovation include industrial development stage, market environment, chain of technology and innovation, national innovation systems, intellectual property policy and other external factors. Furthermore, the absence of long-term training mechanism for the core talented persons in large-scale projects leads to a serious shortage of creative talents. So this paper draws a

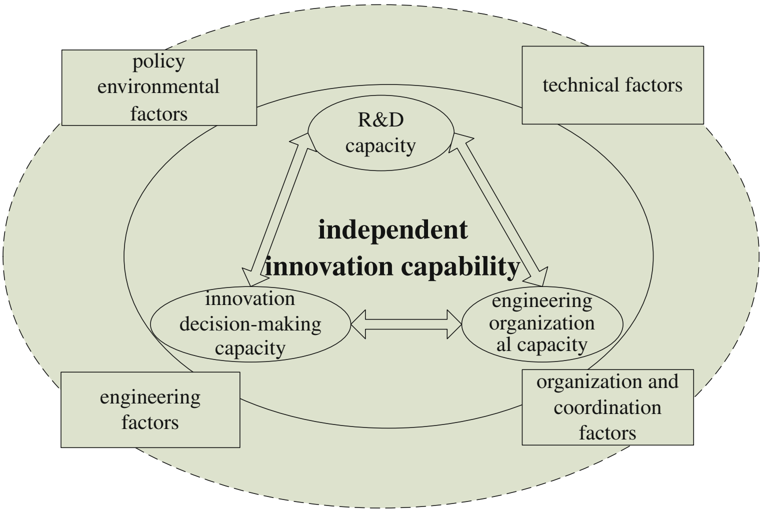

Fig. 64.1 System configuration of independent innovation capability in large-scale projects

conclusion that the main factors of policy environment impacting on independent innovation capacity in large-scale projects involve assessment mechanism for leadership of owner, training mechanism of talented persons, protection mechanism of intellectual property, and the stage and market capacity of related industries.

The engineering factors are also key factors that affect the awareness of independent innovation, which will impact on innovation decision-making of owner. As the technological innovation of large-scale projects is from high degree participation of owner, the requirements of owner become the goals of independent innovation of large-scale projects.

The characteristics of independent innovation, such as uncertainty of innovation cycle, high consumption with capital, lack of practical application in product quality, are conflict with the features of construction projects about fixed completion time, high quality requirements, high quality and budget control of costs. This will impact owners of the construction management team on the strategic choice and incentives attitude about independent innovation for strategic choice and innovation incentives attitude.

Engineering technology is also an important factor, such as viability, advanced degree, complexity, risk, stability of the external supply and easy coding of the technology will exert influence on the innovation decision-making and performance of firms (Ren 2009; Mei 2008). In summary, the main influence of innovation motivation on engineering technology is purchase cost and value of the technology.

Technological innovation of large-scale projects is collaborative innovation in a multi-agent virtual alliance. In the absence of internal expertise, owners of projects should think over how to organize and coordinate the relationship in the R&D

alliance. It is different between project alliances with production alliances. With owners of projects selecting partners of the alliance, and relevance of engineering activities, collaborative innovation will become inevitable. So the paper will only draw an analysis of factors affecting the performance of co-operation. Integrating the temporary alliance of large-scale projects must be dependent on organization and management capacity of owners. Because the administrative level of owner can improve the convenience of integrating project resources, the experienced professionals of project management can effectively coordinate conflicts of the multi-agent innovation.

64.3 System Dynamics Analysis of Independent Innovation Capability in Large-Scale Projects

64.3.1 A Causal Diagram of Independent Innovation Capability

Formation of independent innovation capability in large-scale projects is a multi-layered architecture with complex structure, intricate relationship and multi-objective. System dynamics analysis allows us to study the system evolution from the microscopic structure and build its system model based on the relationship between structures with function. According to system elements of independent innovation ability that generalized in the last chapter, this section will outline a causal diagram of independent innovation ability in large-scale projects (Fig. 64.2). Furthermore, the results of independent innovation, mainly refer to the value of patented technology, which will be selected the characterized element as the independent innovation capability in large-scale projects characterized elements in this paper.

64.3.2 The Analysis of the Main Causal Loop Formation of Independent Innovation Capability

According to Fig. 64.2, there are four main feedback paths to drive the independent innovation capability in large-scale projects.

Feedback path No. 1: "innovation motion of owner- innovation motion of firms -innovation decision-making capacity-performance of independent innovation-innovation motion of owner". In order to improve the capability of independent innovation in large-scale projects, the contractors and owner should first have motion of innovation. Only when the owner has a strong awareness of independent innovation, the local independent firms will be introduced in project. In addition, the incentives for independent innovation of firms that subsidize part of the cost of

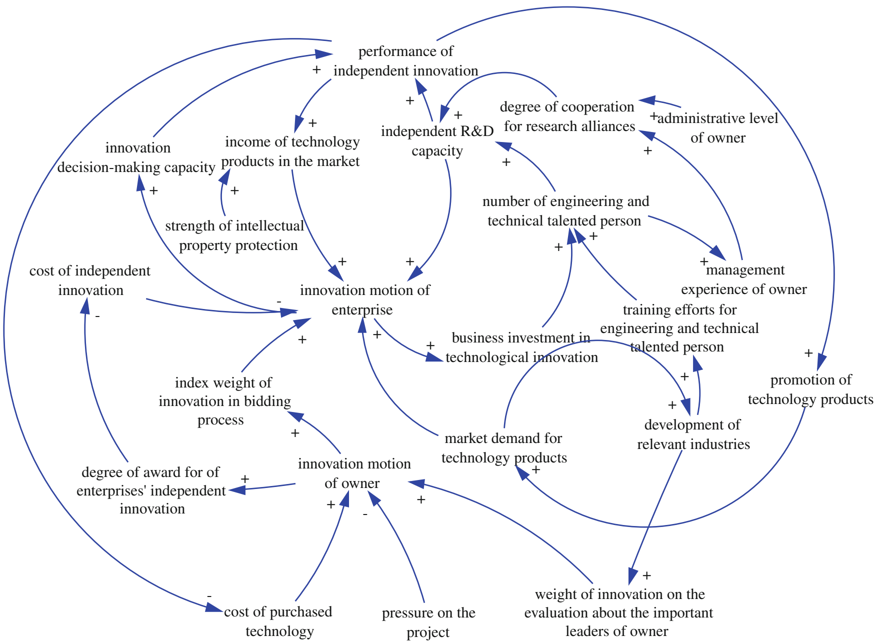

Fig. 64.2 Causal diagram of independent innovation capability in large-scale projects

R&D will enhance the awareness of independent innovation, impact on the innovation decision-making of firms, and ultimately improve the outcomes of the innovative intellectual property. On the contrary, with the reducing cost of purchased technology, and the improving pressure of project duration, cost estimates and high quality of the project, owners will lost the motion of independent innovation, which will effectively restrain the excessive expansion of awareness of independent innovation, and avoid the blind support to some innovation projects without economic and social value.

Feedback path No. 2: "performance of independent innovation-promotion of technology products-market demand for technology products-income of technology products in the market- innovation motion of firms- innovation decision-making capacity- performance of independent innovation". This representation shows that the technology will be spread to other industries because of its high-value, and can also increase demand for those products in the market. Therefore, with the profitability level of technology raising, companies will fundamentally improve the motivation of independent innovation.

Feedback path No. 3: "performance of independent innovation- income of technology products in the market-number of engineering and technical talented person- independent R&D capacity- performance of independent innovation". This feedback loop means the position that improvement of innovation motion of firms exerts positive influence on the investment in technical innovation and the quantity of technical personnel that will result in improving the R&D capabilities of firms.

Feedback path No. 4: "performance of independent innovation- promotion of technology products- market demand for technology products- development of relevant industries- training efforts for engineering and technical talented person-number of engineering and technical talented person-management experience of owner- degree of cooperation for research alliances- independent R&D capacity-performance of independent innovation". From feedback loop 4, this paper shows that the government will support and promote technology products if they have high value. This support can contribute to the development of related industries, to present better results to system of training engineering and technical talented person. When the amount of engineering and technical talented persons has increased, the owner without experience about project can rapidly form an experienced project management team, and the experienced team can help enhancing the degree of cooperation in a research alliance and joint research capability for some high-tech products in a limited period.

64.4 Conclusion

This paper builds a causal model of basic process of the formation and accumulation about independent innovation capability in large-scale projects. The model brings us a preliminary understanding of formation mechanism about independent innovation capability. From the formation mechanism, the paper makes the following suggestions which will help government to draft policy for cultivation of independent innovation capability of large-scale projects.

64.4.1 Draw a Reasonable Appraisal Mechanism of the Owner Leader

The innovative awareness of project owners comes mainly from core leader members. But nowadays the factors of assessment for project managers mainly include the construction time, cost and quality, which lead to enterprise managers' weak sense of innovation. Therefore, the government should add the contribution for development of science and technology into index system of assessment for project managers, such as the number of invention patents, sales volume of patented products, the level of overseas etc. As to the proportion, a topical research should be created in order to balance project construction goals and independent innovation goals for project owners.

64.4.2 Build a Long-Term Training Mechanism for Engineering and Technical Talented Persons

A group of engineering and technical talented person can be trained when participating in large-scale projects. But unfortunately, lots of them will quit to other industries, or "waste" in official careers and government administrative positions. So there is a suggestion that government can try to build a professional management corporation of large-scale projects for owners, which will give a long-term stage for the engineering and technical talented person, but also ensure the organization and coordination experience form project managers.

64.4.3 Insist on Independent Innovation from Market Demand

Since the inventiveness of independent innovation coming from a large-scale project is relatively short, just like "stepping stone", the independent innovation products require a huge market to provide long-term financial support. Furthermore, the increasing market demand will attract new entrants (or foreign firms to enter), but reasonable competition in the market is conducive to the growth of independent innovation capability (Wu 2007). Therefore, the government should carefully select the technology products to be funded. And only reasonable control of funding amount can avoid decision-making falling into the "independent" trap.

64.4.4 Select the Appropriate Departments to Manage the Project

In China, in addition to personnel will exert influence on the ability of collaborative innovation, "power" and "relationship" are also important factors. Therefore it is more efficient to resolute conflicts in a research alliance because of appropriately administrative level of owners.

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Chapter 65
The Preliminary Research of Stock Option Incentive and Good Power Price to Senior Executives of the Listed Companies in China

Hao Zhou

Abstract At present, the high development of Knowledge economy is promoting industries of our country unceasingly, and knowledge plays more and more a vital role in the economic development process. Too relied on the capital the industry originally, because of high energy consumption and high pollution, many companies do not meet the needs of the low-carbon economy to eliminate now; or carrying on the industrial upgrading to enhance the technique of production and the product technique content, increased to the knowledge and the technical request. The stock option incentive involves the question of price formulation. Many foreign scholars have proposed some models to study question, and we can attain profits from the significance but too complex. This article also studies the question of the stock option price. According to the HU theory, this article establishes a mathematics price model, causing the stimulators of the driving plan to be possible to participate fully. And simultaneously it avoids the inappropriate arbitrage behaviors. This article has also carried on mathematics proof to this model, confirming its superiority.

Keywords Incentive · Stock option · Good power price

65.1 The Incentive to Senior Manager

According to the Request—Proxy theory, professional managers, because they have specialized superiority and so on knowledge and experience, have the management authority of the listed company; Correspondingly company's owners are one of the most important shareholders, enjoying the property rights but not

H. Zhou (✉)
Management Institute of Zhejiang Gongshang University, Hangzhou, People's Republic of China
e-mail: zhoulihaochao@163.com

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need to participate in company's current management directly. As senior managers create value for company for their hard working, they have demanded to share the massive surplus values. In order to spur Senior managers create more values, some powerful incentive measures need to be carried on. We can know that senior managers of the listed company own company's management authority. In order to obtain more benefits, different people may be reduced as far as possible because of the possible high cost.

As we all know, public companies should pay wide attention to the benefits of both minority shareholder and other benefit counterparts which include these High-level superintendents. It is known that core staff such as executives is playing a vital role in the routine operation, so sharing part of surplus values with them is not only costs but also revenue in the long run. We need to realize that only taking the benefits of senior managers into account, will they feel a sense of belonging to the company; and only will they feel a sense of belonging to the company, will they do their best for the company. It is also should be realized that short-term incentive is not sufficient and the obsession with short-term benefits can lead huge losses to the listed company. So it is needed to carry on effective measures to spur the core staff of the listed companies.

65.2 Stock Option Incentive

In recent decades, more and more people have realized that the stock option driving plan is one method feasible design, which may have a good driving restraint functions for the listed company high pipe fitting.

First of all, we want to introduce the stock option. The so-called stock option is that the public company awards certain core staff including High-level superintendent, core technologies personnel and other core staff of some rights that they could purchase certain amount stock, in the future. Because of the stock option, it may urge the shareholders to create the value diligently to realize the company value maximization, as benefits of owners and core staffs such as executives are common in some degree. What is more, the stock option materially is one kind of stronger tendency option. High-level superintendent are driven that the object may endeavor by them in certain time, creating certain value for the company, and enable the listed company values to obtain the increment, manifesting in the company share rise. Still so long as stock option's good power price after including the good power spends and so on expenses is lower than the line of temporary company's stock price, High-level superintendents are driven that the object will consider the good power, in which price difference is the income that High-level superintendents may obtain. And stock option may have one kind of latent huge driving function, which will promote them to work hard for better achievement diligently, then creating greater value for the company.

Although after implementing stock option good power spurring plan, stock rights of the listed enterprise may be diluted, the company values created by stock spurring would be greater than not carrying on the stock option. Because of some reasonable system design, even if the stimulator leaves someday, most of them might choose to sell off the company share, then original shareholders enjoy the first purchase power; we may also stipulate that certain special stockholder's rights drive in the plan in stock certain time limiting the circulation, which serves the purpose on controlling the listed High-level superintendent changing job at will. At the same time, it is no needs to use the cash to carry on the drive, which is advantageous in the guarantee to good cash flow.

Although implementing one good stock option plan at the appropriate opportunity might be able to produce good driving results, at the same time we should also consider some limitations and possible existing questions of the stock option spurring. Only understanding the merits and the shortcomings of the stock option driving plan comprehensively, we will make use of it to be better.

We must pay attention to the Macro-economic environment, when the whole national economy moves overheated, like certain time 2007 ago, several of professions economies mostly were on the departure date in the second half of the year, and the stock market was the bull market. At that time, implementing the stock option spurring plan was not proper, even if High-level superintendent were driven that the object did not take. Relying on the good economic situation, even if they did not work hard, it still was possible to obtain good salary. So we may obtain such conclusion that implementing the stock option plan is more cost payout at that time, but the income created from High-level superintendent in the value obtained was insufficient. So that was not best time. Similarly, when our national economy and even the global economic are worn out, various professions economy are when the departure date or just experiencing the big risk crisis, the stock price unceasingly falls, like the second half of the year to present's situation in 2007. Even if High-level superintendent is quite diligent, facing the falling stock price, under certain good power price terms, regarding them is disadvantageous. Therefore, the spurring plan could not achieve the anticipated driving affection. Then it is still not the best time to carry on the stock option driving plan. Similarly it may be the profession difference, even if the big economic environment is the same, some professions are in the rise time, occupies the rise time profession to be listed company to carry on the stock option to drive, must pay a higher cost, but obtaining the relatively insufficient income; Otherwise, the companies in the decline profession, also will meet the phenomenon, because the stock value may decline unceasingly, High-level superintendent will not expect too greatly about the future, therefore, the option drive that also will have the problem. In other words, when the national economy is moving well, the difference, either a profession is when the obvious rise time or the winter is not the best time to carry on the stock option drive.

Therefore, this article supposes that our national economy will move normally, namely in certain time (implements in stock option actuation duration), and the Macroeconomic is not under heating or not overheated circumstance, will not fluctuate greatly.

65.3 Preliminary Study of Good Power Price

Generally speaking, stock option driving plan of the listed company involves some essential factors, such as the stock option awarding object; originate of the stock, good power price, the awarding quantity and good power condition. What is more, the good power price is one core question of stock option driving plan, and the hypothesis of good power price may have something to do with the driving affects in the very great degree, also having direct relation with the listed company and stimulators, the benefit of two sides. In order to study the problem of good power price, this article is under the supposition condition that we have mentioned in front, then studying stock option good power price formulation as well as other correlated questions.

We have to say that the formulation of good power price must observe the related legal rules of our country. As we all know, Securities Supervisory Association has issued "Stockholder's rights of the listed Company Driving Policing method (Implementation)", which was implemented on December 31, 2005, saying that the stipulation of the listed company when awarding the driven object with stock option, they must determine the good power price or the good power price definite method beforehand, and the good power price should not be lower than the following price that is high:

(a) The company sign stock closing price—stockholder's rights drive that the draft plan abstract announces on the preceding trading day;
(b) The company sign stock average closing price—stockholder's rights drive that the draft plan abstract announces in the first 30 trading days.

We may see that this stipulation was only the limited to the stock good power price lower, leaving big space for the good power price's formulation.

Stock option's good power price may be calculated through Blake—Scholes Model, which was proposed by Fischer Black and Myron Schole, who was Nobel economic prize winner, and it is suitable in the stronger tendency western-style option estimate value. Also we can see that this model basis "the non-arbitrage principle" (Arbitrage-free Principle) proposed, and the formula expression is that the stock option value f is equal to the result of the stock current price P_s multiplying the standardized normal distribution N(d1) then subtract the option good power price X multiplying the standardized normal distribution N (d2) multiplying one changing number, namely.

$$f = Ps \cdot N(d_1) - X \cdot e^{-\alpha} \cdot N(d_2)$$

$$d_1 = \frac{\ln\left(\frac{Ps}{X}\right) + rt}{\sigma\sqrt{t}} + 0.5\sigma\sqrt{t}$$

$$d_2 = d_1 - \sigma\sqrt{t}$$

And f is the stock option value, P_s is the stock current price, X for the option good power price, t is the option due time, which is under the stock continual compound interest the year returns ratio standard deviation, N (di) is the standardized normal distribution and it is smaller than di probability (i = 1, 2); r is the non-risk interest rate 1 (Black and Scholes 1973; Chen 2010; Ubelhart 1981; Merton 1973; Cox and Ross 1976; Cox et al. 1979).

However, Blake-Scholes Model had not considered the situation in which the stock option was carried out, and the time of implementing the spurring plan was before the due date. Therefore, this model seems only to be suitable for good power price making of the western-style stock option usually. If it is carried on in good power price making of American stock option, then one big deviation may present. Moreover, if we choose this formula to calculate the good power price, something will seem to be more complex. Because there is a series of limitations, it is difficult to operate in reality (Fang 2011; Hull 1993; Jiang 2003; Sosa and Tian 2000; Dai and Kwok 2008; Necula 2002; Zhang et al. 2008; Li and He 2004; Fu and Yu 2006; Takaoka 2004; Stampfli and Goodman 2003; Benninga 1997; Cuthbertson and Nitzsche 2004). Then the following is the introduction of the stock option good power price formulation application from the HU theory which was established by Professor Zuguang Hu, in April, 2010. And some implications of HU theory have advantages that can avoid the situation in which executives may operate the good power price at will. What is more, the using of implications of HU theory relatively. It is said that some companies that believe the theory have attain great achievement (Hu and Hu 2010). So we try to study HU theory and its implication totally, including its model, implications and the proof.

65.4 The Application of HU Theory in Good Power Price

In front of this article, we have mentioned, because the present's marketing system is not only the consummation, these stimulators own management authority of public company, with suitable resources. As information is not symmetry sometimes, through the property operation as well as the information disclosed and other methods may fry the stock price high in a short time. As a result, the self-interest goal is possible. However, some applications of HU theory may reduce the loss from self-interest behavior through methods designed.

The HU theory establishment's stock option driving model is:

(a) Firstly, the board of directors permit the stimulators proposing a good power date (we suppose that the stock is to be carried in the time of 3 years later) that may be achieved, anticipated company share price P_0;
(b) Line of power price P_e is decided by equation below, then good power price P_e is equal to the result of the company current stock price P_C plus $W * (P_0 - P_C)$, namely

$$P_e = P_C + W * (P_0 - P_C)$$

(c) If stock option price expectation P_0 of stimulators is smaller than future stock actual price Pr from newspaper future, he will receive penalty, and the penalty quantity D is under-report subjects to a penalty the coefficient v and future stock actual price Pr and by the stimulator from newspaper difference of future stock price expectation P_0 product

$$D = v * (Pr - P_0)$$

There are factors needed to introduce, and they are in the following:

P_e is for good power price;
P_C is the company current stock price;
P_0 is the company share price when the good power date which High-level superintendent proposes, is also drove they must realize the goal, P_0 is bigger than P_C; Pr is the stock good power date actual price

W is the weighting factor, and its value is from 0 to 1. When w is 0, the good power price is the current stock price, which is unable to form the restraint to stimulators; When W is 1, the good power price will be the future stock price expectation; if w is closer to 0, then the driving function to stimulator may be bigger; on the contrary, if w is closer to 1, the restraint function to be more obvious. Therefore the value w may be regarded as one kind of adjustment variable. Moreover, this article supposes that our economy will not change greatly in future. However, even if the national economy presents some changes, it is still possible to carry on the adjustment through the value w, so economy fluctuation would not bring too much negative influence. Namely, the suitable accent small w may revise the overheated economy to bring exceeds the quota the driving, w moves in a big way, the question which worn out may alleviate the economy to bring the driving which is insufficient. As W is the adjustment variable value, may act according to the achievement of the listed company achievement, stimulator's performance, the profession characteristic which the Macro economic situation as well as locates is carried on the nimble hypothesis. Simultaneously something need to be considered are different stimulators to company's historical contribution, present's achievement as well as the future the value which will be created for the company.

Differently, V can be seen as a penalty coefficient, is 0–100 % between values. When v is close to 100 %, then the punishing dynamics is bigger. In order to reduce the punishment, High-level superintendent will enhance the future stock price anticipated; which serves to be public company's benefit. Even if High-level superintendent fries stock price high through property operation as well as the information asymmetrical superiority in a short time, also will receive suitable penalty, then avoid the large quantity arbitrage loss. That is, when High-level superintendent the self-interest arbitrage motive is bigger, may suitably raise v value. V value should also not be oversized, oversized, which means that the serious punishment. We also note that the too serious restraint will not favor spurring High-level superintendent to create more values positively for the company.

At last, what we need to stress is that the penalty coefficient value V must certainly be bigger than weighting factor w.

The following content is the explanation of formulation superiority in the stock option good power price about the HU theory. We try to prove that if some rules are designed properly, the spurring function of stock option is very remarkable. What is more, we are able to learn enough inspirations from the HU theory. In order to explain the issues, it is needed to use some examples.

Now the first thing we need to is making a supposition that stock price PC of one public company three years ago was each 100 Yuan, stipulates rear area three years the feasible power, according to this company's growth potential at that time, then the stock price might amount to 120 Yuan three year later. In fact now stock price Pr is truly 120 Yuan. And W is 0.5, V is 0.8. According to the economic man supposition, the human are the self-interest. For arbitrage as far as possible, senior managers will have the following plan alternative:

(a) The first situation is that executives may pull down the anticipated stock price intentionally. For example, they may decide the anticipated company share price P_0 is 110 Yuan, then good power price Pe is equal to the result of the company current stock price PC plus W * (P_0 – PC), namely

$$P_e = P_{C+W} * (P_0 - P_C) = 100 + 0.5 * (110 - 100) = 105 \tag{65.1}$$

punishment quantity is equal to the result of penalty coefficient v multiply the difference of the stock good power date actual price Pr and the company current stock price P_0, namely

$$D = v * (Pr - P_0) = 0.8 * (120 - 110) = 8 \tag{65.2}$$

(b) The second situation is that executives may report the stock expectation price P_0 realistically. For example, they may decide that the anticipated company share price P_0 is 120 Yuan, so the power price is P_e is equal to the result of the company current stock price P_C plus W * (P_0 − P_C), namely

$$P_e = P_{C+W} * (P_0 - P_C) = 100 + 0.5 * (120 - 100) = 110$$

The power price is each 110 Yuan immediately, because this time anticipated stock price P_0 is equal to actual price Pr, therefore does not need to receive the punishment. Final each income R is equal to the result of 120 subtract 110, so we can know the last revenue is 10 Yuan.

(c) The third situation is that the future stock price expectation P_0 is anticipated too high. According to the economic general knowledge, we may know the possibility is very small. If the price expectation is higher than a line of temporary actual price obviously, High-level superintendents of the listed company will appear to be very incompetent, with one defeated feeling. Moreover the good power price P_e is equal to the result of the company current stock price P_C plus W * ($P_0 - P_C$), namely

$$P_e = P_{C+W} * (P_0 - P_C) = (1 - \mathrm{w}) * \mathrm{P}_{\mathrm{C+W}} * \mathrm{P}_0$$

Because weighting factor w is bigger than 0, P_e and P_0 are related, along with stock price expectation's rising, good power price also have a corresponding enlargement. As a result, stimulator's arbitrage space is also compressed correspondingly. Therefore, High-level superintendent do not hope a high anticipation of the future stock price.

In the ordinary circumstances, stimulators would not expect the stock good power price to be too high, even surpassing the actual price. The too high good power price is disadvantageous for them; and setting the stock price anticipated establishment in a high position intentionally is impossible. However, because the HU theory has the penalty factor, which will force High-level superintendent not to be possible the lowland to reduce to future stock each price anticipated, which may cause the final price expectation is as close to actual price as possible. In the synthesis, reporting the stock price expectation realistically conforms to High-level superintendent as well as the listed company' s benefit; if stimulators want stock price expectation to reduce the good power price by more arbitrage through the low newspaper. Likewise, High-level superintendent wants then to carry on the stock option arbitrage through the operation stock price the behavior also to be possible to be similar limits, reducing adverse effect as far as possible in reality. Now the following is mathematics to the HU theory in the stock option good power price formulation's application to prove:

First of all, we want to say that R stands for the last revenue that executives may gain from the listed company stock option incentive plan. As we all know, the last revenue is the result of total revenues subtract the number of punishment quantity and the good power price. Furthermore, we get the following equality: $R = Pr - P_e - D$.

And we also know that D is equal to the result of v * ($\mathrm{Pr} - P_0$), then

$$\begin{aligned} R =& Pr - P_{C-W*}(P_0 - P_C) - v * (Pr - P_0) \\ =& (1 - v) * Pr - (1 - w) * P_{C+}(v - w) * P_0 \end{aligned} \tag{65.3}$$

Because good power price P_e must be smaller than actual price Pr, therefore $P_e = P_C + W*(P_0 - P_C)$ will be smaller than Pr or equal to it.

S*o* $(1 - w) * P_{C\ +\ W} * P_0$ is smaller than Pr or equal to it.

W * P_0 is smaller than Pr − (1 − w) * P_C or equal to it.

Then P_0 is smaller than [Pr − (1 − w) * P_C]/w or P_0 is equal to it.

Supposing [Pr − (1 − w) * P_C] / w = Pr + n, n is one random real number, so we may obtain the following:

$$N = (1 - w) * (Pr - P_C)/w \tag{65.4}$$

So P_0 is smaller than $[Pr - (1 - w) * P_C]/w$ or P_0 is equal to it. And we also know that

$$[Pr - (1 - w) * P_C]/w = P_r + n = Pr + (1 - w) * (Pr - P_C)/w \\ = [Pr + (1 - w) * P_C]/w \tag{65.5}$$

Now we let Y is equal to $[Pr + (1 - w) * P_C]/w$.

Then we may know that the result of (Y – Pr) is equal to n. And n also is equal to the result of $(1 - w) * (Pr - P_C)/w$.

We may know that the current price P_C is smaller than actual price Pr by the front supposition; therefore Pr is smaller than Y. We may also know that present's stock price P_C is known, line of temporary stock price Pr is also the constant which is regarded as to be unable to affect, weighting factor w and the penalty coefficient V one to pass through the hypothesis also to be possible to be regarded as a constant. Now the only variable is anticipated stock price P_0, and P_0 influence income R, i.e. Because we suppose under-report subject to a penalty the coefficient V to be bigger than weighting factor w, simultaneously may see from the above equality increases along with P_0, income R increases. Moreover, we may know by (c), stock option income R and price expectation P_0 is being related, when the number of P_0 is equal to Y, namely $[Pr + (1 - w) * P_C]/w$ may obtain the greatest income. Therefore, according to the HU theory, only High-level superintendent report the stock option expectation price truthfully, will they gain the biggest benefits. As a result, the number that executives give is close to the actual stock price as far as possible. Then when the number executives report is equal to Y, which is the result of $[Pr + (1 - w) * P_C]/w$, they are able to obtain the greatest income. The number of stock price expectation that is closest to actual stock price may reduce the opportunity, because of which High-level superintendent make a profit through the operation of stock price, serving the listed company' s benefit. At the same time, executives of the listed company may also obtain the stock option income after creating the massive values for company.

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Y, which is the result of [Pr + (1 − w) * P_C]/w, they are able to obtain the greatest income. The number of stock price expectation that is closest to actual stock price may reduce the opportunity, because of which High-level superintendent make a profit through the operation of stock price, serving the listed company's benefit. At the same time, executives of the listed company may also obtain the stock option income after creating the massive values for company.

65.5 Conclusion

In our life, the High-level superintendents always have suitable understanding to all kinds of information of this company as well as its competitors. It could be said that they have enough information to affect the stock price sometimes, which is not permitted in law, but they have enough superiority to change something. In the ordinary circumstances, they are able to make very close forecast about this company's stock price in future certain time. Relying on information as well as enough resources, they may operate the stock price by the arbitrage. Although having the related negotiable securities law to supervise, the present law is not still perfect, and some pessimistic regions exist. So it is needed to design some rules to restrain reasonably, and these executives may obtain the proper stock option income after creating value for the company. At the same time, they will not gain too much illegal benefit, as rules that have been designed may compress the space to gain extraneous income.

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Chapter 66
A Review on User Innovation Virtual Community and Suggestions for Future Research

Da-liang Zhang and Yuan-yi Zhang

Abstract User innovation in virtual environment has become an important form, which companies need to promote. However, academic research on user innovation behavior in the virtual environment is far from sufficient. This study reviews user innovation research in the virtual community to discuss the basis and method of user innovation incentives in virtual community and summarizes existing research on innovation performance. Based on it, incentive objects, contextual factors, measurement are discussed for future research.

Keywords Virtue environment · User innovation · Incentive · Literature review

66.1 Introduction

With growing shortage of resources, enterprise innovation system is undergoing dramatic changes. Companies change their relatively closed innovation towards open innovation to take full advantage of resources and build a sustainable innovation system. In response to fast development of Internet economic and increasing number of Internet users, user innovation research has been gradually extended to the Internet context. User innovation in the virtual community gets researchers' attention due to its rapid development and novel form. One of the important questions is how to motivate users. This study reviews the user innovation research in the virtual community, discusses ways to motivate user innovation in the virtual community, summarizes existing research on innovation performance, and lists valuable direction for future research.

D. Zhang (✉) · Y. Zhang
Department of Business Management, Zhejiang University, Hangzhou, China
e-mail: Zdl@zju.edu.cn

Y. Zhang
e-mail: Zhangyuanyihao@163.com

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66.2 User Innovation in Virtual Environment

User innovation refers to new ideas or improvements on products or services by users of these products or services or improvements. There are various form of user innovation. It can be divided into concept and product innovation according to the tangibility level (Hoffman et al. 2010) and to core-module and sub-module innovation according to product innovation domain. By user's position it can be divided into the intermediary and end-user innovation (Bogers et al. 2010). By the platform, it can be divided into the traditional sense of innovation and IT-based innovation. The former appears in traditional product with special using context, such as sports equipment and medical equipment. The latter often appears with information technology, such as innovation on virtual platform (Nambisan 2002), Web 2.0-based innovation (Bilgram et al. 2008), innovation in online communities, and innovation packages.

By leading position, user innovation in the virtual environment can be divided into community-led and user-led one. By different roles of development stages, Nambisan designed a virtual user innovation platform, including interactive mode, knowledge creation, user motivation, and integration with R & D team (Nambisan 2002). Nambisan further integrated theories to discuss that different user motivation may lead to different contribution to community or company (Nambisan and Baron 2010). As for importance of different user, Von Hippel used lead user concept emphasizing willingness and ability differences,while Trusov used influential, mainly referring to one who has major impact on other users in social networking site such as Blog and other content innovation media (Trusov et al. 2010).

Different theories have different interpretations for user behavior in virtual environment. It is believed by theory of social capital that relation can strengthen the commitment of members to help others among the groups, thus contributing to collective action (Nahapiet and Ghoshal 1998). Studies show that in a virtual environment, the more responsible members are, the more likely they could share knowledge and make contribution (Wasko and Faraj 2005). In addition, social exchange theory holds exchange is based on a mutually benefit. A support for this is study which finds reputation and learning promote user innovation behavior (Harhoff et al. 2003). Different theory interpretation enhances the interest of user innovation study in the virtual environment. However, above studies were conducted at individual level, little is known about differences among communities.

66.3 User Innovation Incentives in Virtual Environment

Although there is no systematic theory, guide for user innovation, however, has already developed in two aspects: What is the basis of incentives and the way of it.

Incentives are mainly based on innovation motivation. Volker (Bilgram et al. 2008) reviewed past research and found that in empirical research users innovate to seek happiness of the process, make use of potential ability and creativity and also are driven by external motivation such as money, ease of use and use in special context. Lan (2007) introduced unique product and experience needs to innovation motivation studies, and found unique need affects consumer innovation. Nambisan divided motivation into four categories (Nambisan and Baron 2010), based on different theoretical background: community responsibility, self-image enhancement expectation, professional skills enhancement expectations and the company's partnership. This classification underlines theoretical basis and helps to explain the type and size of the user contribution.

Another basis of incentive is the place played by user in innovation, including the stage and the importance. In innovative design research in virtual community, Nambisan pointed out that users played different roles in different stages, thus leading to different management challenges (Nambisan 2002). He believed that in the stage of the product idea, users play the role of innovation resources and companies are mainly concerned about how to get user knowledge; play a co-creation role in product design and development stage and companies should focus on how to strengthen user knowledge; in product testing and support phase and companies should be concerned about how to promote interaction between users. As for importance, it involves the investigation into target capacity. Von Hipple and other scholars use lead user to depict users with strong innovation willingness and another concept is emergent nature, which refers to innovation characteristics that can identify product market trend (Hoffman et al. 2010). Companies should make different incentive policies based on different role user plays.

According to social exchange theory, incentives can be broadly divided into social-emotional and economic kind (Foa and Foa 1974). Social-emotional incentive will lead to social-emotional results, such as trust and acceptance of company. It shows that trust in business can affect user willingness to innovate (Lan 2007). Virtual community studies have shown that the relationship will affect the user's sense of being respected, thereby affecting the willingness to cooperate in the new product development (Porter 2008) The economic incentive is the incentive in the form of monetary incentives.

There are some gaps. First, the current discussion just stays in the user level rather than the community level. From the community level, scholars can compare communities and find out key incentive model to help to build core competitive advantage. Second, it has not been discussed in depth how users feel as psychological process of incentives (Lin et al. 2007).

66.4 User Innovation Incentives Measurement

After discussion on innovation incentives, there is a need to know incentive performance. The study of organizational innovation performance measurement includes results-oriented and process-oriented measurement (Adams et al. 2006). The former focuses to the cost-benefit analysis from the perspective such as investment in human, material and financial resources, tools and their output market value. The latter considers innovation process, such as knowledge management including idea number, knowledge storage and information flow; innovation strategy including strategic direction and strategic leadership; organizational culture including culture, structure; project management including benefit analysis, communication, cooperation, and commercialization including market research, testing and sales. Table 66.1 summarizes ways of user innovation performance appraisal.

Learning from the above research, user innovation performance measurement in the virtual environment can also include results-oriented and process-oriented forms, as Table 66.1 shows a common practice is to measure product value. Di Gangi and Wasko (2009) defines key product attributes of innovation adoption, including the perception of relative advantage, compatibility, community prevalence and scaled it to measure user innovation value.

66.5 Future Direction for User Innovation Incentives in Virtual Environment

66.5.1 Object

There are two possible innovative behaviors to motivate: one is spontaneous user innovation and the other is under the influence of company or community. These two type is different in motivation and performance, which future research could focus on. The virtual community works as space for consumer to consumer interaction, in which they can interact in pairs or in groups (Libai 2010). Consumer to consumer interaction perspective is future direction of user innovation research. There is difference between single innovation behavior and group innovation. In addition, the difference between online and offline innovation is another problem for making incentive policy. How to make effective incentive to make online and offline innovation behavior promote each other has become valuable in future research. Finally, how to understand the lead user's contribution to the community and the company's growth and profits is also worthy of discussion (Hemetsberger 2002).

66.5.2 Context

Innovation climate in organization studies provides a reference for study on user innovation in virtual community environment. As for definition of atmosphere, there are two different views: one defines atmosphere as objective environment (Mauss 1970) while the other as the overall perception of the environment by the innovation subject, as a product of cognitive experience (Tesluk et al. 1997; Weick 1995).

Table 66.1 Measurement on user involved innovation performance

	Key point	Variable	Area	Paper
Results-oriented	Product attributes	Degree of customization, property quality, external sensitivity characteristics	Open design of online games platform for key product attributes	Yeh
		Perceived relative advantage, compatibility, community prevalence	Key attributes of virtual user innovation	Di Gangi and Wasko (2009)
	Potential value	Investor evaluation	Evaluation of user improvement's commercial value on library information system	Morrison
	Market value	Sales production rate	Innovations adoption in sports community	Franke and Shah (2002)
	Technical value	Number of patents	User innovations on medical device	Lüthje (2003)
	Investment cost	Information costs, support costs	User innovation encouragement's impact on business innovation cost	Lüthje (2003)
Behavior-oriented	Innovation coverage	Innovation ratio	User innovation ratio in total innovation of each industry	Christian Lüthje (2004)
	Innovation cooperation	Information sharing, integration, co-design	User-oriented design	Veryzer (2005)
	Intention to innovate	Have or not	Consumers 'intention to participate in hair design	Lan
	Innovation behavior	Innovation frequency, time	Non-economic incentives on different maturity user	Xie

Future research can focus on cognitive experience to examine the psychological impact of the climate on user innovation. For example, the innovation climate is measured by level and intensity. Level refers assessment of the level of community atmosphere and strength refers to the internal consistency in perception. Organizational innovation studies have demonstrated a positive relation between innovation climate level and performance. Climate strength moderate the relation. The higher the strength, the greater climate level's impact on innovation performance. However, level and strength may have correlation, thus moderate effect may be weakened. Future research can discuss the level and strength of climate on the incentive effects.

The relationship between the community and the individual may affect the innovation incentives effect. Social identity theory (Ashforth 1989) holds that the social identity of individual to his group may lead to some kind of interaction between individual and group, thereby enhances the participation behavior. Identification is critical for users to participate (Muniz 2001). Community identity will increase user's contribution to community innovation and corporate identity will increase user's contribution to enterprise. Future research can use social identity to find out how relationship between the community and the individual affects the innovation incentives effect. For example, according to social identity theory, the identity of a thing may lead to psychological ownership of the things (Pierce et al. 2001), which will help to understand the relationship between the individual and the community. Psychological ownership is a concept proposed by Pierce, which is different from formal ownership. It refers to mind state that one thinks the target is owned by his own and emphasizes the psychological control and possession of the target. There is no formal ownership to the community for users and the use of virtual space can meet the users' self efficacy Future research can focus on potential value of psychological ownership in understanding user innovation.

The type of product may moderate incentives mechanism. Past studies have shown that user innovation behavior is different for different products. Product with a strong "stickiness" will promote a higher level of innovative behavior. Future research could consider the moderate role of the product type on the incentives effect. Also, the life cycle of the product may lead to different types and level of innovation. Future research could consider different innovation incentive policies in different stages of life cycle.

There may be different types of incentives for different virtual communities. Community as for management type can be divided into normative governance community and reputation-based community (Libai et al. 2010). Normative governance is established on normative force and it requires all parties involved to accept rules, make commitment and keep consensus based on reciprocity, dedication, trust. Its rules can be visible or not. Reputation-based community refers to the system designed by community managers with a feedback function, in which members of the different contributions have different social recognition and rewards. These two kinds of community management may also affect the implementation of the user innovation behavior and incentives (Von Hippel and Katz 2002).

66.5.3 Measurement

It can be drawn on other policy measurement for the measurement of innovation policies. For example, in the safety climate study, Zohar described security policy by three factors: Orientation, that is the relative importance compared with other policy, policy coherence, that is the degree of policy changes with environment and simplicity, that is the degree it can be identified (Zohar and Luria 2004).

Future research can learn from multi-level methods in organization research to research innovation performance at both users' level and community's. It is interesting to study the interaction between community incentive policy and user motivation on innovation performance. Also, how does user innovation performance calculate as community performance remains unknown. The multi-level research is direction for future research.

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Chapter 67
Research on the Popularization and Application of the TRIZ Theory in Shanxi Province

Jing-wen An and Xiao-chuan Wang

Abstract The lagging capability of independent innovation has been a bottleneck which restricts the economic and social development in Shanxi Province for a long time. The popularization and application of innovation approaches is the fundamental way to accelerate the development of innovation in Shanxi Province. The main purpose of this article is to in-depth study the core value of the TRIZ theory, which is how to improve the regional innovation capability; by analyzing the usage of innovation approaches in Shanxi Province, to point out achievements and problems, and to provide relevant ensuring measures; thus ensuring and promoting that the implementation of the TRIZ theory in Shanxi Province would be effective and smooth.

Keywords TRIZ · Popularization and application · Independent innovation

67.1 Introduction

Innovation is the eternal topic regarding the survival and development of a business or even a country. Today, improving the independent innovation capability and accelerating the advancing progress of science and technology has become a basic strategy for the development of the world. In the fifth plenary session, October 2005, President Hu Jintao clearly proposed a strategic thought, which is to build China as an innovation-oriented country. Later, Wang Dahang, Liu Dongsheng and Ye Duzheng three scientists raised an important theory "Independent innovation, Method in advance and Innovation approaches are sources of independent innovation" in *Proposal on strengthening the work of innovation approaches*, and it is

J. An · X. Wang (✉)
School of Management, China University of Mining and Technology, Beijing, China
e-mail: wangxiaochuan5852@163.com

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obtained important instructions from the prime minister Wen Jiabao. To effectively popularize advanced technology innovation approaches, the Ministry of Science and Technology of China launched pilot projects for popularizing technology innovation approaches in Heilongjiang and Sichuan province (Ministry of Science and Technology 2008). By using the advanced scientific innovation method, the efficiency and effectiveness of innovation can be improved. The TRIZ theory is one of the most influential theories in the field of innovation design and research. The TRIZ theory can make people follow the nature to innovate, and accelerate the efficiency and quality of innovations, and completely solve problems (Savransky Semyon 2000). The TRIZ theory has been widely applied in the developed countries from Europe, America and Asia, and achieved great success. It is selected from more than 360 kinds of existing innovative methods, and Chinese government put an emphasis on the importance of it. Nowadays, the theory has been introduced into provinces and cities in China, and has effectively popularized and applied in local enterprises.

As a Province with plenty of resource, Shanxi is an important energy and industry base in China, and its development directly affects the implementation of the strategy of the rise of the central region in China. Because of the slow development of independent innovation in recent years, the economy in Shanxi is facing severely problems such as low added value of science and technology products, lack of sustainable development ability, which restrict the development of this region. It gives expressions in: (1) Resource-intensive and labor-intensive industries accounts for a big proportion of industrial structure in Shanxi Province, which restricts the development of sustainable economy. It needs to speed up the technology innovation and new product development, and to promote the existing industries to transform to technology-intensive and high-technology industries, then speed up the pace of the optimization and upgrading of the industry; (2) As an important coal resource province in China, Shanxi Province has made a major contribution to the national economic development, but paid a huge price for the resources and environment impact at the same time, ecological environment situation is not optimistic. The combination of environment protection and economic development should be settled as soon as possible, and it is a typical sustainable development model (Li 2008).

Therefore, as a heavy chemical energy base which coal resources is the core, the future development of Shanxi Province should take a new way to industrialize, which is informatization drives industrialization on while industrialization boosts informatization, and make a new industrialization pathway of high quality of technology, little environmental pollution, low consumption of resources and full usage of human resources. The strategic is to build a new energy and industry base, thus it needs to upgrade and reform traditional industries, to optimize the industrial structure, and to change the mode of economic growth, and efforts should be made during the creation of new technology, new process, optimized product quality and product structure, and raise the contribution rate from the advancement of science to economy, so as to realize the rapid growth of intensive and connotative regional economy (Jian and Yan 2008). To accomplish it, it requires enough industry technical support, and it is urgent to improve the independent innovation capacity of the region. Shanxi Province should realize the importance of independent innovation. In the supporting and guidance from the Ministry of Science and Technology of China, the provincial government should popularize and apply the TRIZ theory, improve the level of science and technology, then lead national innovative provinces and cities.

67.2 Theory

The Chinese translation of the TRIZ theory is "A Theory of Inventive Problem Solving", was established by the former Soviet inventor Genrich Saulovich Altshuller in 1946 (Nie and Yuan 2007). Through analyzing over 250 million inventions and integrating multi-disciplinary theories and rules, the research team led by G.S. Altshuller summarized various general rules and principles which must be followed during inventing, and established the TRIZ theory system that known as the "magic golden touch", then after the practice and development for over 60 years, by now it has become a mature theory and method system in solving the invention problems (Tan 2002).

TRIZ theory, with the technology evolution principle as the core, is a theory & method system in solving the invention problems, and mainly includes nine classical theory systems :(1) 8 laws of technical systems evolution; (2) Ideal final result (IFR); (3) 40 inventive principles; (4) 39 features of Altshuller's Contradiction Matrix; (5) Physical contradiction and 4 separation principles; (6) Substance-field analysis; (7) 76 standard solutions;(8) Algorithm of inventive problems solving (ARIZ); (9) Effect knowledge base (Altshuller 1984).

As shown in Fig. 67.1, TRIZ problem-solving mode, firstly expressing the unsolved invention problem under the TRIZ problem model, then use TRIZ tools to find out the universal solution, finally the optimal solution of the problem can be determined based on the knowledge base and relevant experience. It is a process which guides and inspires innovation personnel to approach ideal result (Fig. 67.2).

67.3 The TRIZ's Mechanism of Improving Regional Innovation Capability

The core of the regional innovation system consists of two levels: the subjects of the regional innovation, as well as connections between them (Asheim and Isaksen 1997). It refers to a such innovative system:In the process of interaction and collaborative innovation where technology innovation is used as a link, and through the rational allocation of innovative talents, funds, material and

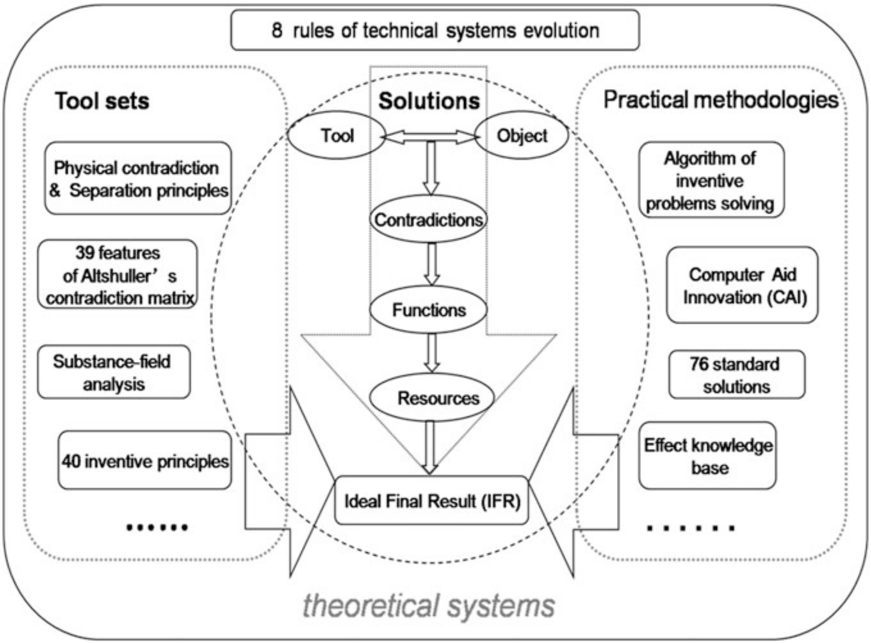
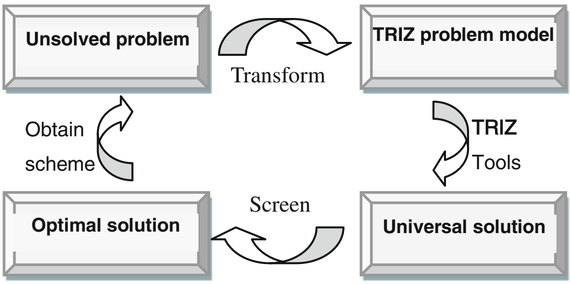


Fig. 67.1 TRIZ theory system

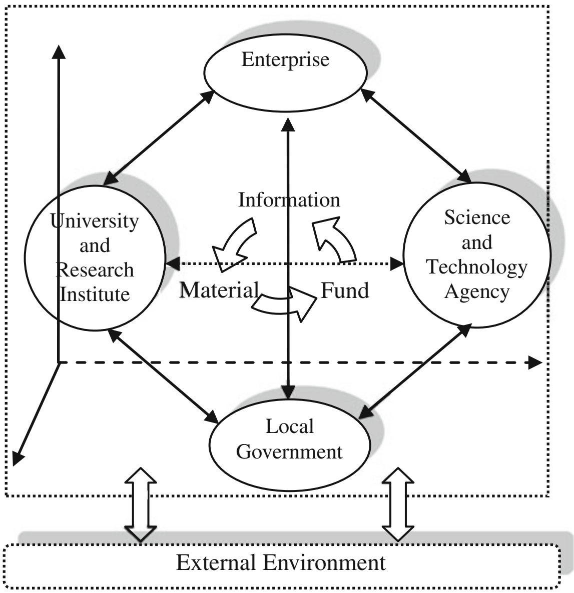
Fig. 67.2 The TRIZ problem-solving method



information resources for innovation, local governments, universities and research institutes, science and technology agencies, and other innovation subjects from a certain geographical area, gradually format a innovative network system which contains creating, stockpiling and transferring knowledge, skills and new products, and it is also a complex adaptive social system, in which the innovation subjects and environment make coordination and common development (Wei 2008). As shown in Fig. 67.3, the local government is responsible for macro-guidance and regulation of innovation activities. Universities and research institutes engage in knowledge innovation and technological research. Technology agencies provide financial support, information consultation, transfer of scientific achievements, technology appraisal and forecast and other innovation services. Enterprises are the main practitioners in innovation activities thus they need strong support from other innovation subjects. Four innovative subjects and their external environments interact and influent each other. They joint control the operation of the regional innovation system. It also can be clearly seen that, external environment closely links to the operation and development of regional innovation system. Through the impact of environmental, TRIZ affects the innovation system of the four regional innovation systems and its four internal subjects. The popularization and the application of TRIZ can create a good atmosphere for regional innovation system, which make innovation main body fully aware of the necessity and importance of the independent innovation (Klein 2006).

TRIZ has already been widely popularized and applied in the developed countries, and achieved great success. Chinese government now also pays a great attention and starts to apply and popularize it in national scope. The introduction of the TRIZ theory, will bring ideas and advanced creative thoughts to the regional innovation system, including encouraging to break thinking inertia and overcoming professional knowledge limitations, focus on problem from innovation frontier, exploring and studying harder, refer to other advanced innovation methods, innovative achievements and innovative ideas; The spread of this innovative ideas and ideals of regional innovation system will form a kind of invisible traction power to local governments, universities and research institutes, science and technology agencies and enterprises, and gradually improves the consciousness of innovation, makes them more positive to do well in their respective regional innovation systems. All subjects should support each other, compliment advantages, and innovate collaboratively, therefore it will cause

Fig. 67.3 Regional innovation system diagram



synergy effect on regional innovation system, and the regional innovation capacity can be increased.

Based on the above research, a mechanism model can be built, which is used for popularizing and applying TRIZ to improve the regional innovation capability, shown in Fig. 67.3. The popularization and application of TRIZ not only expresses advanced innovative ideas and concepts to the regional innovation system; thus each innovation subjects could collaboratively innovate, but also provides a clear picture and standardized methods and tools for solving innovation problems, and accelerates cooperation of each subjects and strengthen the effect. In the mean time, it accelerates the development and evolution of regional innovation system by improving the environment for innovation. It can be clearly seen that the popularization and application of the TRIZ theory can be conducted through above three approaches, and they ensure that the regional innovation system can be efficiently and orderly operated; thus achieving the purpose of constantly emerging innovations and increasing the overall regional innovation capability (Chang and Li 2009). In contrast, the result can help on further improving the TRIZ theory system, popularizing and applying more advanced innovative methods, and forms a virtuous circle (Fig. 67.4).

67.4 Analysis on Popularization and Application of Region Innovation Approaches in Shanxi Province

In the past few years, "The suggestions about improving innovation methods" from the Ministry of Science and Technology of China and other three departments has been thoroughly implemented in Shanxi Province. Considering the provincial situation, the government focuses on training, and launches pilot projects, and uses typical practice as guidance. Based on the research, the popularization and application of the innovation approaches and the TRIZ theory, the government launches a series of works, and achieves good results. Shanxi

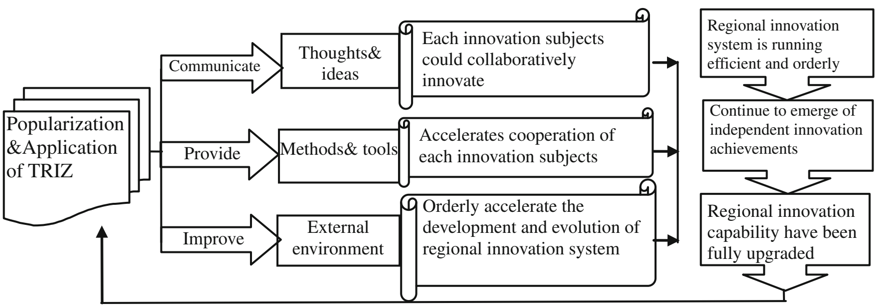


Fig. 67.4 Mechanism model of popularizing and applying TRIZ to improve the regional innovation capability

Province relies on the supporting from the central government and fully exerts advantages of corporations' CAST work. Through speaking tours, expert talks, and pilot enterprise trainings, the training of innovation approaches is widely publicized. It stimulates the public and corporations' enthusiasm for learning and innovating, and they are awareness of the importance of the application of TRIZ. The tour of speaking activates regarding innovation approaches produce a positive response, and the demand of innovation approach training is increasing. A university professor also gives a positive comment on it. In this case, the Association of Science and Technology of Shanxi selects Taiyuan Heavy Machinery Group Co., Ltd. as a pilot, performs technology innovation (TRIZ theory) training to technical staffs and managers from the enterprise (Altshuller 1999), and it solves several technical problems for the company. The action plays a good role as demonstration and guidance for promoting TRIZ training in province-wide. Meanwhile, the Association of Science and Technology continues to strengthen the corporations' CAST work, uses innovation approach training as an important part of activities "Speak & Compare", which accelerates the pace of independent innovation of enterprises (Altshuller 2000).

In the process of popularizing and applying innovation approaches, Shanxi Province achieves several excellent results; however, there are also some problems that restrict the development of region's capability of independent innovation.

1. The sense of innovation and attention to the advanced innovation approaches need to be improved. Compared with Beijing, Shanghai and other developed provinces, the sense of innovation in Shanxi Province is weak, and the awareness and concern of advanced innovation approach of TRIZ is not enough. The incentive is not perfect either, and the corporations are lack of initiative and persistence of innovation activities.
2. Lack of funds for scientific and technological activities and popularizing innovation approaches. This is the main barrier which limits the application of TRIZ in Shanxi Province, making the innovation approach training cannot fully carried out, also restricts the introduction of foreign experts and advanced software tools.
3. Lack of teachers and innovation talents for the TRIZ theory. Existing teachers are far from being able to meet the province's training needs, and professional standards should be completed. The lagging development of the provincial research institutes is another issue. Because of lack of professional and technical person and skilled talent, there is a serious shortage of technological innovations.
4. The agency system is not strong. According to the experience from developed countries, for either the international business or small and medium-sized enterprises, the process of learning and mastering TRIZ theory from agencies is very important. Industry associations and agency organizations play a very important role in popularizing the applying TRIZ (Cui Wen-tao 2011). However, the influence of agencies in Shanxi Province is still weak and small-scale, and they cannot provide professional services. The last but not the least, the traditional education which is exam-oriented has serious drawbacks for a long

time. Students in primary school are not encouraged to innovative thinking, and train their sense of innovation. It restricts the popularization and application of TRIZ theory from the source.

67.5 Safeguards for Popularizing and Applying the TRIZ Theory in Shanxi

The problems mentioned above affected the progress and result of popularizing the TRIZ theory in Shanxi Province. In order to overcome restrictions, to ensure the implementation of the TRIZ theory in Shanxi effectively, and to enhance overall regional innovation capability, the following safeguards should be established after analyzing Shanxi's actual situation and geographical characteristics.

1. Policies and regulations which encourage independent innovations should be established, and create a favorable environment for innovation. It is an important guarantee for popularizing and applying TRIZ. Government should strengthen the relevant provisions and regulations, revise and improve the existing regulations, continue to regulate the popularization of innovation approaches and protect R & D transformation, and build an evaluation system. The IPR protection system should be further improved with strengthening law enforcement, and it would protect the interests and enthusiasm of innovators. Also, technology innovations should be rewarded from financial side. The improvement of financial supporting system and risk investment mechanism would drive companies for more innovations.
2. Strengthening the TRIZ professional team by training and abstracting talents. Innovation talent is the key for regional innovation capacity building, and TRIZ professionals should be trained and attracted through various channels and a variety of ways. The government should also focuses on team building and reserves young talents. Shanxi Province should implement the program of abstracting TRIZ professionals right away. The program should include increasing the investment in research and income for innovation talents, providing funding to professionals, and establishing an evaluation and incentive system.
3. Agencies system should be perfected, and also need to establish TRIZ agencies and related associations. Based on the requirements for the development of technology innovation in Shanxi Province, the government should drafts relevant preferential policies and development plans for agencies, and makes sure that the area distribution, geographical distribution, as well as the types and levels are reasonable. In particular, increasing the supporting for the construction and development of TRIZ agencies and industry associations, and enhancing the service quality. The management of TRIZ agencies should also be regulated, and the government has to switch its role from lead position to an

agent. The agencies service would become a major force for popularization and application of the TRIZ theory in Shanxi Province (Wang and Wang 2010).

4. Reformation of the education system, promoting the quality education, and bring up the sense of innovation in public. Innovation education should be executed from kids, and independent thinking, practice and innovating should be encouraged. In addition, the government should publicize TRIZ theory through various media, and enhances the public awareness of innovation.

67.6 Conclusion

The TRIZ theory founded by Altshuller is actually a method and tool for invention and innovation. It successfully reveals the internal rules and principles of invention, and makes the innovation become orderly to follow, and is no longer blind and accidental; It can help people developing innovative thinking, breaking thinking inertia, accurately grasping the problem and finding the final direction and then to explore the optimal solution, thus greatly improving the speed and quality of innovation behaviors; It can help us predict and grasp the trend of technology innovation based on the nature of technology system evolution. TRIZ could be called the Marxist philosophy in scientific field and the Bible which should be read by technologists '".

The main means of popularizing TRIZ innovation tools and enhancing enterprises' independent innovation capability are the keys of constructing technical innovation system in which using enterprise as the main body, production, research and study combined as a group. It is from the source of the independent innovation, and a work of building the innovative country's groundbreaking, long-term and basis. As an underdeveloped resourcing province, the lag of the regional innovation capability chronically restricts the development of economy and society in Shanxi Province. Using TRIZ can speed up and improve the independent innovation capability and the comprehensive competitiveness of Shanxi. We should try to popularize and apply the TRIZ theory well in Shanxi Province combining the actual situation, and make full use of all kinds of innovation resources. The popularization and application of the TRIZ theory can help enterprises improving the efficiency and the quality of innovation, and help the Shanxi Province increasing the independent innovation capability, accelerating the process of innovative province construction, achieving the sustainable development of regional economy with exhausted coal resources, smoothly passing the critical period of "Transformational development and Leaping development", and effectively and efficiently achieving the goal of building a "Innovative Shanxi".

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Chapter 68
Study on the Performance Indicator Weights of Higher Agricultural Education Resources Anagement Based on the Triangular Fuzzy Function

Li Zhang, Yan-li Zhao and Liu-cheng Zhang

Abstract The triangular fuzzy function has been constructed based on triangular fuzzy theory, we have analyzed statistical findings of the performance indicators importance for the management of higher agricultural education resources, the triangular fuzzy function has been solved through the method of gravity center, then the fuzzy weights of performance indicators have been determined.

Keywords Higher agricultural education · Performance indicators · Triangular fuzzy number

As an important part of higher education of our country, Higher agricultural education is the key of agricultural education, is the important base of high-level agricultural personnel training, scientific research, technology promotion, industry development and technology innovation. In recent years, our country higher agricultural education realized the leap of reform and development which has a positive impact and role to the national social economy especially the development of the rural economy (Zhang 2008). However, there are little effective allocation and management mechanism between the limited higher agricultural education resources and the rapidly developed agricultural economy. That brings about the function of higher agricultural education resources supporting economic development can't fully express and causes part effective resources waste. Therefore, to speed up the establishment of efficient management system of higher agricultural education resources and take fully advantages, is not only the knowledge security that effectively putting the development strategy of revitalizing the nation through science and education into effect, but also the important rely which promotes

L. Zhang (✉) · L. Zhang
Practical Teaching Management Center in Harbin University of Commerce,
Harbin 150028, China
e-mail: zhangli007008@126.com

Y. Zhao
College of Management in Harbin University of Commerce, Harbin 150028, China

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regional characterized economy develop steady and healthy (Jin 2002; Zhou 2008; Wenbing and Hao 2008).

This paper has made statistics and analyzed the investigation result of the importance of the higher agricultural education resource management performance index by the micro angle of the performance management, combining its own characteristics of higher agricultural education resource management and structuring triangular fuzzy function based on the triangle fuzzy theory. Solve the triangular fuzzy function by Center of Gravity Defuzzification and finally determine the fuzzy weights of performance indicators have lay the foundation for the performance evaluation index of the higher agricultural education resources management.

68.1 Resources Management and Performance Evaluation for the Higher Agricultural Education

Agricultural education which combines both narrow and broad cents is a kind of social activities to train agricultural talents. General education of agriculture refers to all of activities which spread agricultural science and technology knowledge and train agricultural talents. Special education refers to all kinds of agricultural school education. Higher agricultural education is not only an important part of the entire education system but also a characteristic branch in higher education (Zheng and Lei 2009). It is a professional education activity concerning about agriculture and the related which is on the basis of the common education. It includes not only higher agricultural education in all levels, but also other education related to the field of agricultural science and technology.

From the point of view of the resource property, we can distinguish higher agricultural education resources into the physical resources and the invisible resources. Among them, scientific research management personnel, education facilities and education expenses are included in the physical resources, while agricultural science and technology management knowledge, education skills, atmosphere and interpersonal relationship in the education field of internal and external (Junping and Wen 2010). Therefore, higher agricultural education resources can be regarded as a collection which higher agricultural education is relied to exist and develop in. It's an integrated system coming from the interaction by personnel, funds, infrastructure, management system, teaching and scientific research. On the basis of human, material and financial resources, through a serious of synthesis applications of management technology, management procedure and management methods, higher agricultural education resources and management make adjustment and optimization on all elements in order to produce the best society benefit (Zhang 2009a; Song and Zi 2008).

In conclusion, higher agricultural education resource management performance evaluation is a process that checks and measures the internal and external effects of higher agricultural education resources and management by various managements and evaluation methods. On the purpose of discovering problem and solving problem timely, higher agricultural education resources and management system makes adjustment and optimization continuously in the changing inner and outer environment, in order to expose on the state of the best social effect (Xu 2002; Li and Yang 2007).

68.2 The Triangular Fuzzy Number Expression of the Important Degree of the Higher Agricultural Education Resource Management Performance Index

In the research, by the application of the triangular fuzzy number, translating the importance of the quantification extent into an analyzable quantitative number, thus eliminating the unreasonable due to personal subjective factors. According to the earlier research achievement about the key factor of higher agricultural education resources and management, among the experts who are engaged in relevant work, aiming at some expert group survey which five first class indexes and twenty-six second class indexes of higher agricultural education resource management performance are included in, they survey each unit (the expert group) for the cognition to the important degree of each performance index (Zhang 2009b; Shen 2009).

The design of the word corresponding fuzzy number is for the standard of seven scale, The design of the semantic variable calculated amount is regarded as triangular fuzzy number, as is shown in Table 68.1. Ninety-nine questionnaires were issued. The expert group made the important degree of fuzzy semantic measure for the first and second stage performance evaluation indexes while withdrawing seventy-seven copies. Combined with uncertainty analysis of the statistical methods of triangular fuzzy numbers, making sure fuzzy weights by the weight analysis, thus achieving each index weight tendency from the expert group, we got triangular fuzzy number forming the expression of the index by the maximum, minimum and intermediate value.

Establishing fuzzy weights by triangle fuzzy number measuring method, transforming the original quantification of the important extent into the quantitative numerical that can be analyzed, in order to eliminate unreasonable due to

Table 68.1 The triangle symmetrical fuzzy number notation of higher agricultural education resource management performance evaluation indexes weights

Fuzzy number	1	2 Not very important	3 Not important	4 General important	5 Important	6 Some important	7 Very important
Triangular fuzzy number representation	(1,1,2)	(1,2,3)	(2,3,4)	(3,4,5)	(4,5,6)	(5,6,7)	(6,7,7)

personal subjective factors, includes all index importance opinion from the experts, so that we can get more objective and accurate weights in the questionnaire survey results.

68.3 The Statistics and Analysis of the Results of the Survey About the Importance Degree in Higher Agricultural Education Resource Management Performance Index

Let's collect and settle the expert group survey. Then, we get some statistic information of higher agricultural education resource management performance index in the importance degree. Making the following data calculation and volume management, we can see the results in Tables 68.2 and 68.3.

Among them, the standard deviation described the degree of dispersion which the expert group evaluated the importance degree of the performance index. The standard deviation much smaller, the importance degree value of the performance index more close to the mean value degree and vice versa. The standard deviation is calculated on the basis of the mean value which impacts the standard deviation. The standard deviation coefficient, the coefficient of variation, represents the differences that the experts approve on the performance index importance. Therefore, we should take the coefficient of variation into reference. The smaller the coefficient that relative degree of difference is smaller, then the degree of dispersion of the performance index importance will be smaller. This suggests that the social identification of the experts in performance index importance more concentration. The standard error: Std.D < 1. Finally, we structured the range expression of the triangular fuzzy weight of various performance indicators on the basis of maximum, minimum and the intermediate value.

In the above research process, because of collecting the weight information through different units of expert group, so it's inevitable that the analysis results will have some degree of variability. Both of the coefficient of variation and

Table 68.2 The analysis sheet of the results of the survey statistics about the importance in higher agricultural education resource management performance index (one class index)

Performance indicators	Arithmetic mean	Standard deviation	Coefficient of variation	Std.D	Triangular fuzzy weight
A human resources	0.1901	0.01471	0.09137	0.0031	(0.1734,0.1901,0.2067)
B funds	0.2221	0.01250	0.08467	0.0026	(0.2045,0.2221,0.2357)
C infrastructure	0.1631	0.02015	0.1104	0.0036	(0.1501,0.1631,0.1712)
D management environment	0.1542	0.02432	0.1479	0.0033	(0.1428,0.1542,0.1643)
E research output	0.2705	0.01129	0.08357	0.0021	(0.2611,0.2705,0.2809)

Table 68.3 The analysis sheet of the results of the survey statistics about the importance in higher agricultural education resource management performance index.(Level 2 index)

Performance indicators	Arithmetic mean	Standard deviation	Variation coefficient	Std.D	Triangular fuzzy weight
A1 the quantity of teaching and scientific research personnel	0.2043	0.0272	0.0885	0.0033	(0.1911,0.2043,0.2104)
A2 the proportion of teaching and scientific research personnel	0.2815	0.0230	0.0912	0.0028	(0.2734,0.2815,0.2916)
A3 master or higher number of teaching staff	0.2541	0.0223	0.1043	0.0041	(0.2447,0.2541,0.2615)
A4 overseas quantity	0.1322	0.0372	0.1012	0.0035	(0.1207,0.1322,0.1483)
A5 external research personnel quantity	0.1279	0.0401	0.0904	0.0021	(0.1191,0.1279,0.1325)
B1 per total funding	0.2607	0.0347	0.1002	0.0023	(0.2517,0.2607,0.2757)
B2 per research funding	0.2512	0.0350	0.0745	0.0027	(0.2431,0.2512,0.2670)
B3 per education funding	0.2013	0.0325	0.1100	0.0033	(0.1942,0.2013,0.2100)
B4 per infrastructure funding	0.1720	0.0400	0.1023	0.0030	(0.1602,0.1720,0.1870)
B5 total investment funds of GDP	0.1148	0.0350	0.0971	0.0031	(0.1100,0.1148,0.1523)
C1 the member of university with more than ten thousand people	0.2258	0.0233	0.0701	0.0025	(0.2113,0.2258,0.2309)
C2 the proportion of Higher agricultural education	0.1732	0.0306	0.0839	0.0029	(0.1621,0.1732,0.1846)
C3 network construction	0.2012	0.0542	0.1007	0.0022	(0.1973,0.2012,0.2107)
C4 multimedia classroom quantities	0.1704	0.0297	0.0931	0.0047	(0.1645,0.1704,0.1801)
C5 fixed assets worth	0.1150	0.0301	0.0999	0.0031	(0.1076,0.1150,0.1217)
C6 intangible assets worth	0.1144	0.0405	0.1012	0.0030	(0.1040,0.1144,0.1200)
D1 the constitution of related policy laws and regulations	0.2031	0.0315	0.0857	0.0020	(0.1924,0.2031,0.2127)
D2 constraint and incentive mechanism	0.2015	0.0364	0.0899	0.0031	(0.1943,0.2015,0.2123)
D3 the proportion of professional management staff	0.1906	0.0210	0.0997	0.0021	(0.1878,0.1906,0.2011)
D4 relevant administrative departments	0.2013	0.0565	0.1300	0.0023	(0.1957,0.2013,0.2122)
D5 broadcast and training	0.2035	0.0500	0.0955	0.0029	(0.1975,0.2035,0.2123)
E1 university enrollment	0.1108	0.0305	0.1135	0.0041	(0.1023,0.1108,0.1215)
E2 graduates	0.2217	0.0337	0.0807	0.0022	(0.2159,0.2217,0.2308)
E3 an average annual award for the master degree	0.2257	0.0410	0.0999	0.0027	(0.2111,0.2257,0.2310)
E4 an average annual above provincial scientific research project number	0.2407	0.0176	0.0700	0.0031	(0.2322,0.2407,0.2519)
E5 an average annual research results award number	0.2011	0.0299	0.1022	0.0030	(0.1933,0.2011,0.2108)

standard deviation reflect the concentration trend. That is the representation of the mean arithmetic, the greater the coefficient of variation, the lower the concentration of trend representatives. As shown in Table 68.3, *The D4 related management department* has the largest standard deviation and coefficient of variation. This is mainly because that the relevant departments in different units are different, and even some units don't separate specialized management. Therefore, different expert groups feel the difference in understanding of this index weight normal. In addition, in Table 68.3, standard deviation and coefficient of variation of E4 growth research project number above provincial and ministerial level are minimal. That's because the scientific research project plays a vital role in the efficiency of higher agricultural education scientific research project resource management. It's an industry consensus. Therefore, different expert groups have few of differences on the degree of cognitive on this index.

68.4 Solving the Fuzzy Weights of Higher Agricultural Education Resources Management Performance Evaluation

In order to overcome the uncertainty of the subjective judgment, using fuzzy number to get a clear value can more intuitively reflect the weight of the expert group judgment. Here, the process to determine the weight values is the process to solve fuzzy problems. There are many methods to solve fuzzy problems, without fixed program, as long as some criterions in reasonable, simple in calculation, continuity. The gravity solution to solve fuzzy problem, is a kind of common and rational method.

Suppose a fuzzy set for M, the membership functions for $\mu_M(X)$, $x \in X$, $DF_i(M)$ is the explicit value after conversion of the gravity solution to solve fuzzy problem.

Then, $DF_i(M) = \frac{\int_x x\,\mu_M(X)dx}{\int_x \mu_M(X)dx}$, among them, the denominator $\mu_M(X)$ is the acreage and $DF_i(M)$ is the shaft position where the center of gravity of the projection is.

According to the gravity method, through a group of triangular fuzzy numbers combined with performance index weight maximum value, minimum value and the intermediate value in Table 68.2 and Table 68.3, after treatment in defuzzification and uniformization, the fuzzy weight value of the second stage performance index will be shown finally in Table 68.4.

Table 68.4 The fuzzy weight value table of higher agricultural education resource management performance evaluation

Weight index	Level 1 indicator	Level 2 indicator				
		A	B	C	D	E
1	0.1910	0.2017	0.2592	0.2215	0.2023	0.1167
2	0.2203	0.2790	0.2503	0.1745	0.2021	0.2207
3	0.1647	0.2547	0.2017	0.2002	0.1900	0.2212
4	0.1607	0.1327	0.1725	0.1709	0.2047	0.2391
5	0.2633	0.1319	0.1163	0.1165	0.2009	0.2023
6	–	–	–	0.1164	–	–

68.5 The Experts Selected Tendency Analysis of Higher Agricultural Education Resource Management Performance Evaluation Fuzzy Weights

1. Pay Attention to Input and Output Efficiency

After the statistical analysis of the recovered questionnaire, we can easily to find in Table 68.2 that the weight values of investment and research outputs are the maximum, the standard deviation and coefficient of variation are the minimum and the difference of fuzzy weights of the index value in the level 2 index of the level 1 is the minimum, as is shown in Table 68.3. This indicates that different expert groups have the same attention degree on funding and research output, while the little difference in two grade index further explains the value degree of the expert group in input and output.

2. The Hard Environment and Soft Environment of the Relative Weakening Management

In Table 68.2, one class index shows that different expert groups pay the same attention to the funding and research output. The little difference in two grade index explains the expert groups' value degree for input and output.

The fuzzy weight value of infrastructure and management is minimum, while the relative standard deviation is maximum and the coefficient of variation is relatively large. It means that the expert groups have large difference in the recognition between infrastructure and management. The vast majority of expert groups made relative weakening selection on the importance of the five level 1 indicators. This shows that, at present, China's relevant departments relatively neglect the dual role of infrastructure and management in higher agricultural education resource management, while the abroad pay more attention to the double construction of hard and soft environment.

3. Begin to Pay Attention to Academic Exchanges

In the retracted questionnaires, individual experts put forward a influence factor called the regional or international academic conference. Through consulting we realize, some areas or units especially some institutions in low level, have little conscious or unconscious to do academic exchanges and cooperation, because of budget and system constraints. This impedes the utilization of higher education resources advances management ideas and methods and the raise of improvement of management level. Although, only individual experts suggest this effect, it's enough to illustrate that our country's higher agricultural education researchers and practitioners have begun to recognize the problem. With the advance of our higher agricultural education resource management, the influencing factors will become the effectively complement to the evaluation index system.

68.6 Conclusion

In the process of collecting questionnaires and expert consultation, we found that Chinese researchers and workers urgently needed a set of scientific, reasonable higher agricultural education resources management performance evaluation index system, in order to grasp higher agricultural education resource management better. Due to the late of our country's relevant work, therefore, related research was lagging behind. At present, the relevant domestic research literature on higher agricultural education resources management performance evaluation that can be referred was little. As the determination of higher agricultural education resources management performance evaluation index weight value having many subjective factors, so how to accurately determine the weight of index value is a difficult point in higher agricultural education resource management evaluation index system research. In view of this, on the basis of 26 important indicators screened in the previous work, this article made a large attempt in this field advantage of triangular fuzzy number. Through questionnaires, using a 7 point rating value form, selecting each index from the different expert groups in the same industry to undertake evaluation, determining the expression range of triangular fuzzy value, finally through the center of gravity defuzzification can we get the fuzzy weight value of level 1 indicator and level 2 indicator, thereby to overcome the uncertainty of the subjective judgment effectively. The specific application of triangle fuzzy method will provide a new train of thought for higher agricultural education resources management performance evaluation research work.

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Chapter 69
Research on Sustainable Develop of Chinese Family Enterprise Based on Independent Innovation Ability

Yu-chun Sun, Xiu-ming Sun and Wen-zhuo Wang

Abstract Family enterprises become the basic power of China's economic development and growth. Sustainable development is important for both family enterprises and our society. Independent innovation ability is the critical impetus for sustainable development. Family enterprises' independent innovation ability directly affect the enterprises' sustainable development level, so we must understand China's family enterprises' independent innovation ability accurately. By drawing on theory of innovation and family business, this paper establish an evaluation model referring to <China independent innovation ability analysis report> and EIC (Europe innovation scoreboards); then we collect and analyze data from <Industrial Enterprise Technology Activities Statistics>. We find that the independent innovation ability of Chinese family enterprise needs to be developed more in the future. Only by improving the independent innovation ability, can the family enterprises become more sustainable.

Keywords Ability · Family enterprise · Independent innovation · Sustainable develop

69.1 Introduction

Family business is an old and pervasive type of enterprise form all over world, and makes a significant contribution to the world economy (Donckels and Frohlich 1991). Foreign scholars began to pay attention to family enterprise since 1950s, while Chinese scholars began their research this field since 1980s (Chrisman et al. 2002;

Y. Sun · X. Sun (✉) · W. Wang
Department of Economic and Management, University of Tongji,
Shanghai, China
e-mail: xiuming110@163.com

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Anderson and Reed 2003). The study involving many aspects, despite that, little is known about innovation ability of family business (Jess and James 2010).

China is a country which has the longest and deepest cultural traditions of “family”, “family” plays an important role in social life, economic life and cultural life, and even in political life. Because of “family” has flexible meaning in China, Chinese scholars define “family business” mostly by description and analysis, but lacking of specific quantitative research method or model (Han and Zheng 2004). At present, it still is an exploration period of enterprises’ independent innovation ability, which have no mature theory, what’s more, there is much less research on the independent innovation of family enterprises’ (Lin 2003).

Enterprises’ independent innovation ability is a lasting and strong motive force for sustainable development. Family enterprises’ independent innovation ability can directly influence the enterprises’ sustainable development level (Bergfeld et al. 2011). Consequently, investigating the independent innovation ability with a family firm background can drive family enterprises improve themselves more efficiently, and drive government pay more attention to family enterprises. This paper contributes wide practical and theoretical value.

We begin by providing the theoretical foundations of our considerations. Next, we develop an estimating model of independent innovation ability with family business backgrounds. Then we collect data from <Industrial enterprise science and technology activities statistics> from 2001 to 2007, and present the results of our analysis (Industrial enterprise science and technology activities statistics 2001–2007). After outline our findings, contributions and limitations, we provide our conclusion and the possible avenues for future research.

69.2 Model

During the “eleventh five-year plan” period of our country, there are more than 8.4 million private enterprises, which increased at an annual average rate as high as 14.3 %, and accounts for 74 % of the total enterprises (Su 2011). 90 % of the private enterprises are family enterprises, so family enterprises have become the basic power of China’s economic development and growth (All-China Federation of Industry and Commerce 2006).

In order to estimate the independent innovation ability of family business, we build a model including four first-level indicators: potential innovation resources, technology innovation activities, technology innovation output capacity, and innovation environment which is the most important factor that influent independent innovation. So the first-level indicators mainly consider technology innovation ability of family business, which come from the <China independent innovation ability analysis report> (National Bureau of Statistics of China 2004). As the second-level estimate system, we selected 23 indictors from input and output view. The estimate model can be seen in Fig. 69.1.

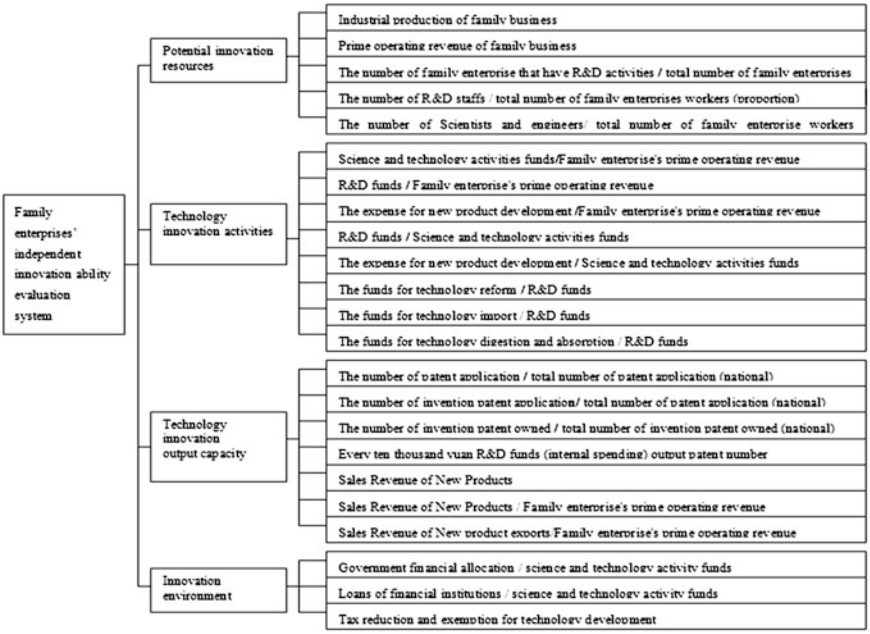

Fig. 69.1 Evaluation model

69.3 Analysis

69.3.1 Potential Innovation Resources

The Table 69.1 shows that both the industrial and primary operating revenue of family enterprises are all increased steadily from 2000 to 2007, and the growth rate of them is increased year by year (Ding et al. 2008). But the ration of family enterprises that have R&D activities has no obviously improvement, maintaining at the rate of 20 %.

R&D staffs account for 0.91–1.54 % of all the employees. The proportion is not improved either. The factor of proportionality that the scientists and engineers account for the R&D staffs is lower than that in developed country.

69.3.2 Technology Innovation Activities

From 2000 to 2007, family enterprises have paid more and more attention on the technology innovation activities. First, the expense for technology innovation activities had significant growth, increased from 93.962 million yuan to 3.4098 billion yuan, and the cost in 2007 is 36 times as that in 2000. Second, R&D

Table 69.1 Data for potential innovation resources

years	Industrial production	Prime operating revenue	Enterprises numbers	Total number of Family Enterprises workers	The number of family enterprise that have R&D activities	The number of R&D staffs	The number of Scientists and engineers
2000	4787933	4636877	476	276564	113	4255	5557
2001	10906928	10156485	936	530196	184	6565	9375
2002	16350186	15711566	1263	726715	273	9720	13884
2003	56445399	54045696	2852	2259403	624	27777	37091
2004	95096191	91063068	4525	3293824	799	30036	42082
2005	141338664	135845508	5398	4198387	1014	44789	67493
2006	199378321	193302327	6755	5037721	1406	67310	89382
2007	277076946	268615030	7979	5892351	1690	90243	119708

internal expenditure and new product development expenditure also had an increase. Third, there were some fluctuations in the funds for technology reform, for technology import, for technology digestion and absorption. On the other hand, there was a large gap between China family enterprises and developed country (Wu and Lin 2007). Whatever S&T activities expenditure or new product development expenditure, even R&D internal expenditure, were all accounted for little proportion of the whole primary operating revenue. Half of S&T funds were used to develop new products, but the R&D internal expenditure was less than 50 % of S&T funds. We can deduce that Chinese family enterprises are more emphasis on the new product development and research. Most of the S&T funds were expended on technology reforming, and only about 0.47–2.79 % were expended on digesting and absorbing the technology imported. The funds of Chinese family enterprises for technology reform cost increased progressively from 2000 to 2003, but actually there was a dramatic decreasing trend since 2004. There was a same situation for the technology import cost (Table 69.2).

Table 69.2 Data for technology innovation activities

years	Science and technology activities funds	R&D funds	The expense for new product development	The funds for technology reform	The funds for technology import	The funds for technology digestion and absorption
2000	93962	27312	37420	35598	11218	1211
2001	150752	44757	68020	97007	33301	661
2002	214927	77315	100062	204373	51137	4829
2003	612901	223675	278072	849298	118585	6065
2004	1028833	408611	434254	1079199	33447	17100
2005	1597969	644171	1056874	1273794	68933	28570
2006	2265332	1052648	1501652	1691496	105607	57564
2007	3409877	1476612	2219170	1950933	121848	97738

69.3.3 Technology Innovation Output Ability

We found from Table 69.3 that both sales revenue of new product and sales revenue of new product export were increasing obviously from 2000 to 2007, and the sales revenue of new product grew much faster than that of new product export. The new products revenue contributed about 10 % to the primary operating revenue, varied from 7.39 to 13.80 % during 2000–2007. The export new products sales revenue contributed not so much for prime operating revenue, only accounted for about 2 %. Patent is another important indicator for examining the innovation output ability besides new products sales revenue. We can see that the number of patent application increased sharply in recent years, and was faster than invention patent application. But there is still a large space for the number of invention patent owned to improve. Taking into account the number of national patent applications, patent application from family enterprises accounted for nearly one-fifth in 2007, the percentage grew from 1.79 to 17.34 % during seven years. We can infer that family enterprises have strong potential innovation ability. Invention patent application from family enterprises accounted for little of the total patent application. It was less than one percent in 2000. However this situation is further improving, the invention patent owned by family enterprises increased significantly from 1.05 to 11.81 %. It means that family enterprises are playing more and more important roles for independent innovation (Lin 2005).

69.3.4 Technology Innovation Environment

From Table 69.4, we can draw a conclusion that the technology innovation environment is not so good. Financial institution's loans make a larger proportion for fund collection than the government, but it decreased from 37.79 to 14.91 %, which means the financial environment for family business is not sufficient and efficient. Government should allocate more funds for family business to innovate, and should give more preferential tax to encourage family business.

Table 69.3 Data for technology innovation outpu ability

years	Sales Revenue of New Products	Sales Revenue of New product exports	The number of patent application	The number of invention patent application	The number of invention patent owned
2000	639997	74900	212	73	67
2001	1259395	235804	743	159	343
2002	1651940	467315	1371	162	372
2003	3992307	1057247	3700	412	3090
2004	8496105	2352146	6264	1058	1987
2005	12022943	2972426	8382	1351	2850
2006	18427012	5169710	9809	1885	4613
2007	27540868	6665487	16631	2312	5154

Table 69.4 Data for technology innovation environment

years	Government financial allocation	Loans of financial institutions/science and technology activity funds	Tax reduction and exemption for technology development	Enterprises funds	Other funds
2000	1001	28193	571	63476	980
2001	4923	24345	2334	117408	3807
2002	3919	32467	3613	175085	3187
2003	12005	97553	9146	493064	7344
2004	22292	157984	34821	832112	12161
2005	37600	228760	28589	1285369	40690
2006	49132	364405	48963	1820627	28864
2007	83717	522372	47571	2751590	47920

69.4 Discussion

69.4.1 Limitation

Due to the difficulties of data collection, we just analyze the data from 2000 to 2007, which influenced our findings on some level.

Meanwhile, we just considered Chinese family enterprises' independent innovation ability, excluding other kinds of enterprises (state-owned enterprises or foreign capital enterprises). It will be better if we can compare Chinese family enterprises with other kinds of enterprises or developed countries' family enterprises. Then we can have a more clear and accurate perspective on Chinese family enterprises' independent innovation ability.

69.4.2 Avenues for Future Research

Our study may spur future research in several directions. Firstly, scholars can study on the estimating model of family enterprises. Secondly, comparative research between Chinese family enterprises and other kinds of enterprises is a new field. Thirdly, comparative research between Chinese family enterprises and developed countries' family enterprises can benefit for our independent innovation ability improving.

69.5 Conclusion

Our findings offer an outline perspective on the independent innovation ability with family business backgrounds.

First, Chinese family enterprises have large potential to innovate. Both hardware(S&T activities and funds) and software (R&D staff, scientists and engineer) are increasing with rapid speed.

Second, Chinese family enterprises have made a good contribution and improvement to the independent innovation output, such as new product sales revenue, patent application and owned (China private economy research family enterprise research group 2011).

Third, there is still development space for Chinese family enterprises to enhance their independent innovation ability. A gap between our family enterprises and other developed country's actually exists. For example, invention patent application and owned by Chinese family enterprises are much less than that of Germany family enterprises, sales revenue of new product import is little in Chinese family enterprises.

Fourth, government should do more for establishing a favorable innovation environment. Offering sufficient funds allocation, encouraging financial institution to provide more loans to family enterprises, expanding the tax reduction and exemption scope and amount, all these measures can promote family enterprises to innovate independently.

We contribute to research area in a number of ways and hope to inspire other researchers to conduct additional work in the fascinating field of family enterprises' independent innovation ability.

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Chapter 70
Organizational Advantage, Social Capital and Organizational Learning

Yi Dong

Abstract According to the knowledge-based view, the organizational advantage of firms over market comes from their ability in acquiring and creating knowledge through learning. In this study, organizational learning is conceptualized as a process of social interaction, which is promoted and constrained by the structural, relational and cognitive dimension of social capital. Based on a dynamic perspective, we also distinguish the sources of social capital and argue that organizational learning is conductive to the development of social capital in return. A framework is provided to show how firms achieve organizational advantage through the coevolution of social capital and organizational learning.

Keywords Organizational advantage · Social capital · Organizational learning

70.1 Introduction

In contrast to the transaction cost theory, which views the organizational advantage as lying in the attenuation of market opportunism, more researches have emphasize on the firms' distinctive capabilities over other institutional arrangements, such as market (Nahapiet and Ghoshal 1998). Scholars are paying more attention to open the black box and figure out the differentials of firms. However, how organizational advantage is generated still remains to be a fundamental issue in the field of organization theory and strategic management. In this article, we attempt to address the problem on the basis of organizational learning and social capital.

According to the knowledge-based view, organizations could be conceptualized as a learning system for acquiring and creating knowledge. The accumulation of

Y. Dong (✉)
Department of Enterprises Management, Zhejiang University,
Hangzhou, China
e-mail: dongyi0313@163.com

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knowledge through learning would gives rise to the sustainable growth of firms. Nowadays especially, many firms are facing with the diminishing competitive power in regime of rapid change, which makes learning a more important issue for organizational development. Besides, with the trend that firms are networking firmly with each other, learning confined to a single organization become inefficient. Different forms of organizational network appear, making the concept and pattern of organizational learning even broader.

As organizational learning is considered as a process of social interaction (Huber 1991), the role of social capital should not be overlooked. Based on literature review of social capital, we identify the sources of its dimensions (structural, relational and cognitive dimension): opportunity and motivation. Different components of social capital promote and limit organizational learning in different way. Furthermore, we propose that organizational learning would in turn conduce to the social capital's dynamics. The organizational advantage is achieved through the interaction of social capital and organizational learning.

70.2 Sources of Social Capital

For this study we define social capital as the set of resources embedded within, available through, and derived from the network of relationships possessed by an individual or social unit (Nahapiet and Ghoshal 1998). Differing from economic capital and human capital, social capital's sources lie in the structure of actors' social relationships (Coleman 1988). It's the relationships among actors rather than the focal actor that create value in the social capital research. While the impetus of market exchange is easily understood (people make resources accessible in order to get the pay), the exchange of social capital resources is more complicated. Especially, why do the donors share resources without immediate returns or even a symmetrical commitment? Goodwill, such as sympathy and trust has been regarded as the substance of social capital (Adler and Kwon 2002). The motivation of the donors, however, should be more essential than just that. Coleman emphasizes the effects of norms and sanctions on generating social capital, so that the crimes in city are inhibited (Coleman 1988). Portes distinguishes two classes of motivations. The first one is "consummatory", including value introjections, which is caused by the norm internalization during the process of socialization, and bounded solidarity, which is generated by the identification with one's own group and community. The other one is "instrumental motivations", including the reciprocity exchanges, where the expectation of repayment is based on the resources of the recipient, and enforced trust, where the obligations are enforced by the social structure.

Other than the motivation of the donors, Adler and Kwon also take the opportunity and ability into consideration (Adler and Kwon 2002). In their research, embedding in the network structure, which may be characterized as closed (Coleman 1988) or full of structural holes (Burt 1992), has great impacts on the generation and possession of social capital. Besides, the abilities at other nodes of the network determine the potentially mobilizable resources. However, many researches doubts that abilities are only complements to social capital, because subsuming other form of capitals would make the concept social capital too broad (Portes 1988).

Following the “narrow” perspective towards social capital, this research identifies two sources of social capital: opportunity and motivation. The “opportunity” refers to whether and how the actor is embedded in the social structure. The “motivation” refers to the extent that other actors are willing to assist.

In this article, Nahapiet and Ghoshal’s three dimensions of social capital is adopted: structural (the configuration of relationships, including network ties and network configuration), relational (the content of relationships, including trust, norm, obligation and identification) and cognitive (the resources providing shared interpretation and representation, including shared language, codes and narrative) (Nahapiet and Ghoshal 1998). According to the connotation and denotation of the two concepts, we propose that “opportunity” is the origin of the structural dimension. Furthermore, as the motivated actors interact frequently and deeply, a high level of trust, norm and shared language would develop, suggesting that “motivation” is the origin of the relational dimension and cognitive dimension.

70.3 Organizational Learning

According to the knowledge-based approach, the firm is conceptualized as an institution for integrating knowledge and learning (Grant 1996). Former studies assume that the learning process has identified stages. For example, in Huber’s comprehensive review, four constructs are related to organizational learning: knowledge acquisition, information distribution, information interpretation, and organizational memory (Huber 1991). Similarly but more operationally, Nevis, Ghoreishi and Gould develop a three-stage model of learning: knowledge acquisition, knowledge sharing and knowledge utilization (Nevis et al. 1995). From a network perspective, Podolny and Page identify two ways of learning: first, network facilitates knowledge transfer among firms; second, network becomes the locus of knowledge creation (Podolny and Page 1998). Following these views, this article conceptualizes organizational learning in the context of network as a process of knowledge acquisition and knowledge creation.

70.3.1 Social Capital and Knowledge Acquisition

Network provides firm with access to various types of resources, information and technology. The informal ties in network play an important role on knowledge transfer and acquisition. The most valuable information is always obtained from the acquaintance who is found to be reliable, rather than the market or the formal chain of command in an organization (Powell 1990). The effect of social capital should be considered seriously.

As mentioned before, we accept Nahapiet and Ghoshal's dimensions of social capital: structural, relational and cognitive (Portes 1988). They have impacts on firm's knowledge acquisition in different ways: who you reach and how you reach them (the structural dimension) influences the availability of the knowledge; how much you trust each other (the relational dimension) influences the openness of the knowledge; how well you understand each other (the cognitive dimension) influences the efficiency of the knowledge exchange. Several studies have examined the role of social capital in facilitating knowledge acquisition. Granovetter points out that the strong ties have greater motivation to assist than week ties, and thus could promote the knowledge transfer (Granovetter 1983). Such positive association will increase with the tacitness of knowledge being transferred (Hansan 1999). Reagan and McEvily find that social cohesion and network range positively influence the ease of knowledge acquisition (Reagans and McEvily 2003). To the broader aggregates, Inkpen and Tsang distinguish three common network types (intracorporate network, strategic alliance and industrial districts) and argue how social capital affects the transfer of knowledge between network members (Inkpen and Tsang 2005).

However, some empirical researches show that the effects in different dimensions are not uniform. Based on the sample of 180 new high-tech Ventures in UK, Yli-Renko, Autio and Sapienza examine how social capital in key customer relationship affects the knowledge acquisition (Yli-Renko et al. 2001). The result indicates that the social interaction and network ties dimensions are positively associated with knowledge acquisition, while the relationship quality dimension is negatively associated with knowledge acquisition. In Presutti, Boari and Fratocchi's research about foreign development of high-tech start-ups, while structural dimension positively influence the knowledge acquisition, both relational and cognitive dimensions have negative effects (Presutti et al. 2007). One possible explanation for the negative effect may be that the overembeddedness in few relationships would insulate firms from other external resources and knowledge (Uzzi 1997). Furthermore, the high-lever trust and identification could lower managers' motivation and capability to monitor the changing environment, resulting in the failure of timely knowledge acquisition (Dyer and Singh 1998).

70.3.2 Social Capital and Knowledge Creation

Organizational knowledge is created through a continuous dialogue between tacit and explicit knowledge, requiring a high level of social interaction and mutual trust between individuals (Nonaka 1994). As a consequence, social capital has been considered as a key factor in knowledge creation. Nahapiet and Ghoshal suggest that social capital facilitates the creation of new intellectual capital through combining and exchanging knowledge (Nahapiet and Ghoshal 1998), which has been supported by another empirical research (Tsai and Ghoshal 1998). In different dimensions, the number of exchange partners provides the actors with access to new resources and information, and the quality of the relationship is beneficial for establishing mutual trust and emotional support, and developing the jointly held knowledge. In the empirical research, Moran finds that both the structural embeddedness and relational embeddedness are positive with innovation (Moran 2005).

However, some researches also find a curvilinear relationship, suggesting that parallel increases of outcome may not come with increased social capital. Knowledge creation is the result of balance between social interactions and solo activities, but the establishment and maintain of more relationships may shorten the time for individual activities. Moreover, the strength of relations could produce strong norms, mutual identification and a similar knowledge stock among network members (Coleman 1988; Adler and Kwon 2002). At the individual level, McFadyen and Cannella's research reveals that both the number and strength of relations are quadratically related to knowledge creation (McFadyen and Cannella 2004). At the firm level, Molina-Morales and Martinez-Fernandez find an inverted U-shape relationship between trust and innovation creation (Xavier and Teresa 2009).

From these reviews, the optimal configuration of organizational social capital becomes an important issue for the managers, for the reason that insufficient relationships would limit the flow of social capital resources, while redundant ties may bring costs and risks. Besides, different components of social capital have dissimilar impacts on organizational learning. For example, in Yli-Renko, Autio and Sapienza's empirical research, social interaction between firms is beneficial to knowledge acquisition, and relationship quality has the opposite effect. One of the reasonable explanations may be that structural dimension of social capital reveals the power of week ties, and the relational and cognitive dimensions show the importance of strong ties. As a consequence, the complex relationship between social capital and organizational learning should be explored cautiously.

70.4 Coevolution of Social Capital and Organizational Learning

In this article, organization is the institutional setting for both the development of social capital and organizational learning. The potential advantage of organization over market might arise from its superior abilities of learning (Ghoshal and Moran 1996). The central argument is that firms could achieve organizational advantages through the coevolution of social capital and organizational learning. Figure 70.1 summarizes the overall conceptual framework that will guide the discussion. We have discussed about the path from social capital to organizational learning, so in this part our main focus is in the development of social capital.

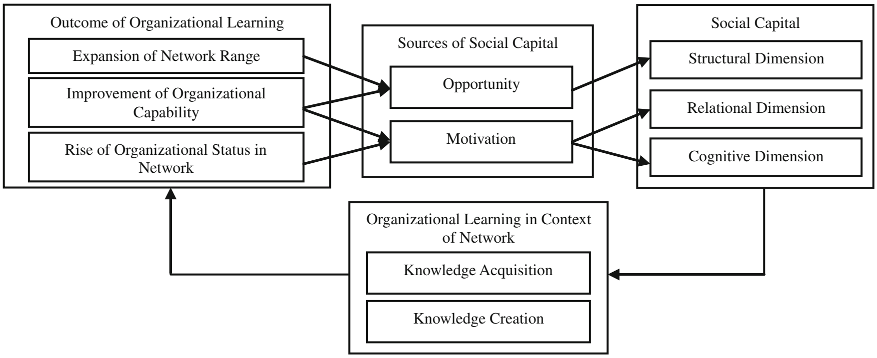

Fig. 70.1 Coevolution of social capital and organizational learning

70.4.1 Dynamics of Social Capital

How does social capital evolve over time? A dynamic perspective towards social capital is of significant importance. First, organizations are facing with various task and resource requirements at different development stages (Maurer and Ebers 2006). The relationships should be renewed to adapt to the evolving environment. Second, as network is conceptualized as a set of nodes and ties, the interaction of nodes' action and ties' structure would promote the development of network (Brass et al. 2004). Third, because of the tautology in social capital studies, a static research is unable to capture the antecedents and consequences of social capital (Portes 1988).

Though important, the challenge still remains about the factors that influence social capital's dynamics. In Brass's review, three conditions are considered to be influential to network evolvement: the joint effect of network's opportunities and constraints, the resources and capabilities of the network actors, and the cross-level pressure. Nahapiet and Ghoshal argue that time, interdependence, social interactions and network closure are the four necessary conditions for social capital's development (Nahapiet and Ghoshal 1998). Using a longitudinal case, Maurer and Ebers examine how "social capital inertia" is created and overcome. In their research, the internal organization of firms' management of relationships, through horizontal and vertical differentiation and integration, could contribute to the development of social capital (Maurer and Ebers 2006).

70.4.2 Interaction of Social Capital and Organizational Learning

We have suggested that social capital is regarded as a critical factor for firms' organizational learning. In the dynamic view of social capital, we propose that organizational learning is a way to overcome the so-called "social capital inertia".

Three outcome of organizational learning is identified in the context of network. The direct advantage of learning is the development of organizational capability. With unique capability, firms have the right to determine its network structure (more "opportunities") and attract more desirable partners (more "motivation" of other actors). Second, firms seek to explore more knowledge through organizational learning, meaning that new relationships are built and network range is largely expanded. Third, as organizational learning is a process of social interaction, firms have more chance to organize relationships so that the organizational status in network would rise. Other actors are more motivated to establish ties, because high status always means trustiness and legitimacy in the network. It could be included that organizational learning conduces to the social capital learning though creating "opportunity" for the focal firms and "motivation" of other network actors.

It could be concluded that organizational advantage is achieved through the interaction between social capital and organizational learning. Generally, social capital promotes organizational learning through its structural, relational and cognitive dimension, while advanced organizational learning creates the opportunity and motivation for social capital's dynamics. Thus organization is advanced and renewed in the process of coevolution.

70.5 Conclusion

The aim of this study is to provide another insight to understand the source of organizational advantages. Innovation is no longer constrained in a separate organization, provided that network is becoming the locus for knowledge transfer and creation. Except for the formal relationships in the form of hierarchical governance or contracts, managers should attach great importance to the establishment of informal ties, thus the organization could benefit from the emeddedness of the broader network.

Theoretically, we attempt to (1) identify the source of different dimension of social capital; (2) synthesize the effect of social capital on knowledge acquisition and creation; (3) adopt a dynamic view of social capital and identify the interaction of social capital and organizational learning. From the perspective of social capital and organizational learning, we seek to explore how organization produces its unique advantages. Still, some remained problem should be paid attentions. First, while structural dimension of social capital indicates the power of week ties, the relational and cognitive dimensions mainly focus on the importance of strong ties. So grouping all dimensions of social capital into one index may not lose some explanatory power. Second, the effects of intraorganizational and interorganizational social capital on organizational learning should be investigated separately, so as to comprehend the different mechanisms of various types of ties. Thirdly, although the model is presented, the empirical research of social capital's dynamic is far from sufficiency. Especially, despite a lot of empirical researches, the mature scale for measuring social capital still lacks. Future researches could take these issues into consideration.

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Chapter 71
Inbound and Outbound Open Innovation in Clusters

Yin-jie Xu and Jian-zhuang Zheng

Abstract This paper investigates the impact of the inbound and outbound open innovation on innovative performance in firms of industrial clusters. We argue that firms with higher levels of absorptive capacity manage external knowledge flows more efficiently and stimulate innovative outcomes. And in a cluster with more trust between the firms, firms will achieve higher innovative performance through outbound open innovation. What's more, we discuss open innovation in firms of labor-intensive, capital-intensive and technology-intensive industrial clusters, respectively. We argue that sourcing and revealing are more popular than acquiring and selling in firms of labor-intensive clusters. However, acquiring and sourcing are both very popular while revealing is more popular than selling in firms of capital-intensive and technology-intensive clusters.

Keywords Innovation performance · Inbound open innovation · Outbound open innovation

71.1 Introduction

Zhejiang province, one of the most prosperous regions in China is home to various industrial clusters ranging from labor-intensive (e.g., clothes, neckties, and flooring) to capital-intensive products (e.g., equipment manufacturing and automobile parts). In recent years, industrial clusters developed very rapidly in both scale and

Y. Xu (✉)
School of Management, Zhejiang University, Hangzhou, China
e-mail: xymstc@163.com

J. Zheng
Business School, Zhejiang University City College, Hangzhou, China
e-mail: zjzd2@163.com

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economic benefit in Zhejiang. There are more than 300 industrial clusters with annual sales above 1 billion in Zhejiang Province. Among those industrial clusters, there are 5 clusters with annual sales above 100 billion. The 5 clusters are Hangzhou equipment manufacturing cluster, Shaoxing textile cluster, Xiaoshan chemical fiber textile cluster, Yongkang hardware cluster and Ningbo clothing cluster.

However, there are some problems in Zhejiang's industrial clusters. One of the critical problems is the "double lock-in", which stands for two situations. In one situation, the whole industrial chain is locked at a low level. And in the other situation, part of the industrial chain is locked at a low level. In the labor-intensive industrial clusters, firms imitate with each other within the same cluster. They hardly learn from the excellent firms outside the cluster. As a result, their products lack the technology and they have low profits. The whole industrial chain is locked at a low level. In the capital-intensive or technology-intensive industrial clusters, although there are several superior firms in the cluster, they are reluctant to transfer their redundant patent or technology to other firms within the same cluster. As a result, the majority is locked at the low part of the industrial chain and the cluster can not develop in balance. In a word, the former ignores the search strategy for the knowledge and technology and the latter does not open toward outside to share knowledge. The two situations just reflect the firms are lack of open innovation, which has two faces-inbound and outbound.

Chesbrough first proposed open innovation as a new paradigm for the management of innovation in Chesbrough (2003). Open innovation is defined as the use of outflows and inflows of knowledge to promote internal innovation, and to expand the markets for external use of innovative ideas, respectively. It comprises both outside-in (inbound) and inside-out (outbound) movements of technologies and ideas. Open innovation has received increasingly attention both in theoretical research and business practice, but so far it has hardly been analyzed in inbound and outbound simultaneously. Moreover, although the relationship between open innovation and innovative performance has been studied in prior works, the mechanism of the process is considered as a 'black box'. This study addresses this gap by considering both inbound and outbound open innovation and studying the mechanism of how open innovation affects innovative performance.

71.2 Conceptual Background

The role of networks, communities, and linkages has been more and more popular in investigations of innovation. Spithoven et al. (2010) indicates that open innovation is not new; already in the 1980s many authors comment on how the approach towards innovation changed from a closed model to a model in which firms across industries started to increasingly rely on the acquisition of external technologies to complement their technology portfolios. Chesbrough and Crowther (2006) divides the concept of open innovation into two main types of activities:

inbound open innovation and outbound open innovation. In the case of inbound open innovation, ideas are external to the firm, stemming from suppliers, customers and other external actors (through technology in-licensing, acquisition or joint development), increases the innovativeness of the firm. In the case of outbound open innovation, companies look for external organizations that are better suited to commercialize (part of) the firms' given technology (for instance through intellectual property or brand out-licensing). Dahlander and Gann combine bibliographic analysis of all papers on the topic published in Thomson's ISI Web of Knowledge (ISI) with a systematic content analysis of the field to develop a deeper understanding of earlier work. Their review indicates two inbound processes: sourcing and acquiring, and two outbound processes: revealing and selling in (Dahlander and Gann 2010). Sourcing refers to how firms can use external sources of innovation. Acquiring refers to acquiring input to the innovation process through the market place. Following this reasoning, openness can be understood as how firms license-in and acquire expertise from outside. Revealing refers to how internal resources are revealed to the external environment. In particular, this approach deals with how firms reveal internal resources without immediate financial rewards, seeking indirect benefits to the focal firm. Selling refers to how firms commercialize their inventions and technologies through selling or licensing out resources developed in other organizations.

In aspect of inbound open innovation, Ahuja and Katila (2001) examines the impact of acquisitions on the subsequent innovation performance of acquiring firms in the chemicals industry. Ahuja and Katila find that within technological acquisitions absolute size of the acquired knowledge base enhances innovation performance, while relative size of the acquired knowledge base reduces innovation output in. Katila and Ahuja's findings in the global robotics industry suggest that firms' search efforts vary across two distinct dimensions: search depth or how frequently the firm re-uses its existing knowledge, and search scope or how widely the firm explores new knowledge (Katila and Ahuja 2002). Zhang and Li (2010) examine the relationships between new ventures' ties with service intermediaries and their product innovation in the context of a technology cluster. They propose that new ventures' ties with service intermediaries enable the ventures to plug into these networks and contribute to the ventures' product innovation by broadening the scope of their external innovation search and reducing their search cost. Using a large-scale sample of U.K. manufacturing firms, Laursen and Salter (2006) link search strategy to innovative performance, finding that searching widely and deeply is curvilinearly (taking an inverted U-shape) related to performance. In Chen et al. (2011), analyze how the innovative performance is affected by the scope, depth, and orientation of firms' external search strategies. They apply this analysis to firms using STI (science, technology and innovation) and DUI (doing, using and interacting) innovation modes. Based on a survey among firms in China, they find that greater scope and depth of openness for both innovation modes improves innovative performance indicating that open innovation is also relevant beyond science and technology based innovation.

In aspect of outbound open innovation, Lichtenthaler uses data from 136 industrial firms to test four hypotheses on the moderating effects of environmental factors in the relationship between open innovation strategies and firm performance. The results show that the degree of technological turbulence, the transaction rate in technology markets, and the competitive intensity in technology markets strengthen the positive effects of outbound open innovation on firm performance. By contrast, the degree of patent protection does not facilitate successful open innovation (Lichtenthaler 2009). Lichtenthaler and Ernst (2009) and Ernst use data from a survey of 154 industrial firms are to test three hypotheses relating technology aggressiveness, external technology acquisition, and external technology exploitation. The results show that technology aggressiveness is negatively related to the extent of external technology acquisition and is highly positively related to external technology commercialization. Lichtenthaler and Ernst (2007) have shown that most firms' External technology commercialization (ETC) activities are still relatively limited in comparison with internal technology exploitation, i.e., product marketing. Owing to the high margins that may be realized in these activities, however, successful ETC operations may strongly contribute to the operating income of firms. As this aspect had only been described for the examples of some pioneering firms, their results have provided empirical evidence for this fact. Furthermore, a considerable increase in ETC over the past 5 years could be observed, and firms that do not actively address this issue will tend to fall behind their competitors. As ETC may have a considerable impact on a firm's product business due to its strategic dimension, e.g., by setting industry standards, successful ETC may essentially contribute to firm performance. When come to the other process of outbound open innovation, Henkel argues that revealing is strongly heterogeneous among firms. Multivariate analysis can partly explain this heterogeneity by firm characteristics and the firm's purpose behind revealing. An analysis of reasons for revealing and of the type of revealed code shows that different types of firms have different rationales for openness (Henkel 2006). von Hippel (2007) discusses three conditions under which user innovation networks can function entirely independently of manufacturers. He then explores related empirical evidence, and concludes that conditions favorable to horizontal user innovation networks are often present in the economy.

71.3 The Mechanism of How Open Innovation Affects Innovative Performance

Spithoven et al. (2010) indicates that firms may open up their innovation processes on two dimensions. While inbound open innovation refers to the acquisition of external technology in open exploration processes, outbound open innovation describes the outward transfer of technology in open exploitation processes. Prior open innovation research has focused on the inbound dimension, whereas the outbound dimension has been relatively neglected. Therefore, we address the relationship between inbound/outbound open innovation and firm innovative performance.

71.3.1 Inbound Open Innovation and Innovative Performance

The use that firms make of external knowledge in the production process is called inbound open innovation in (Chesbrough and Crowther 2006). But this external knowledge does not percolate smoothly through the boundaries of the firms. Knowledge has to be identified first; and firms have to look for mechanisms to assimilate and transform this knowledge. In other words, they have to rely on absorptive capacity to take advantage of inbound open innovation.

Stated in Spithoven et al. (2010), Cohen and Levinthal argue that the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends is critical to its innovative capacity. Therefore the concept of absorptive capacity is the key in understanding successful inbound open innovation, which is characterized by the reliance on external knowledge. According to Cohen and Levinthal, the ability to evaluate and use outside knowledge is a function of the knowledge source and the level of prior related knowledge and depends on the ability to appropriate this external knowledge. As a result, firms with higher levels of absorptive capacity manage external knowledge flows more efficiently, stimulate innovative outcomes and thus obtain competitive advantage.

71.3.2 Outbound Open Innovation and Innovative Performance

Outbound open innovation refers to outward technology transfer, and it suggests that firms can look for external organizations with business models that are suited to commercialize a technology exclusively or in addition to its internal application in Chesbrough and Crowther (2006). Therefore, outbound open innovation points to actively pursuing external technology exploitation, which refers to the commercialization of technological knowledge exclusively or in addition to its internal application, e.g., out-licensing.

In the process of open innovation, if a firm goes too far in emphasizing the protection of internal knowledge, it will be isolated by other firms. Therefore, it can not acquire the knowledge from outside. In other words, proper outbound open innovation can prevent a firm from being isolated by other firms and improve its influence in the innovative network. As a result, outbound open innovation is positively related to innovative performance. Prior research into outbound open innovation has primarily focused on internal factors, e.g., complementary assets. Because of the inter-firm nature of open innovation processes, the effect is not exclusively determined within the firm. Instead, transaction cost theory underlines the role of a firm's environment in outbound open innovation. It is hard to make 'keep or sell' decisions independently from a firm's environment. We propose that the relationship between outbound open innovation and innovative performance is influenced by environmental moderators. If firms in a cluster trust in each other, they will release more knowledge. Firms can get more knowledge they need and improve their innovative performance. As a result, in a cluster with more trust, firms will achieve higher innovative performance through outbound open innovation.

71.4 Open Innovation in Different Types of Industrial Clusters

We divide industrial clusters of Zhejiang Province into 3 types: labor-intensive, capital-intensive and technology-intensive. The importance of inbound and outbound open innovation may differ in different types of industrial clusters. Again, we consider two inbound processes: sourcing and acquiring, and two outbound processes: revealing and selling in different types of clusters. We will discuss this issue in detail in the following parts.

71.4.1 Labor-Intensive Industrial Clusters

Labor-intensive clusters in developing countries are often marked by low wages, unskilled work, and sweatshop conditions of employment. Labor-intensive industries are particularly susceptible to vertically disintegrated network forms of organization and to large-scale labor pooling processes, and both of these features promote agglomeration, especially where producers face intensely competitive and unstable markets. Tendencies to agglomeration are boosted by localized learning effects. As a result, in the process of inbound open innovation, firms in the labor-intensive clusters tend to implement sourcing rather than acquiring. Meanwhile, the low-technology nature of these firms makes it easy to learn from each other. Therefore, it is difficult for these firms to prevent revealing, one type of outbound open innovation. Because there is little intellectual property in these firms, acquiring and selling are not popular in labor-intensive clusters.

Stated in Scott (2006), in more advanced agglomerations, the bottom tiers of the production system seem nowadays to be less and less strongly tied to local accretions of competitive advantages, and many of these agglomerations are now rapidly losing significant shares of their low-end production activity in spite of widespread employment of cheap immigrant workers. One of the great policy issues for agglomerations in less developed countries therefore is how to achieve quality upgrading and to escape from the low road of pure price competition. We therefore propose that the breadth of these firms' open search strategy should be expanded. Laursen and Salter (2006) identifies 16 sources of information and knowledge for innovation activities in U.K. manufacturing firms. They are suppliers, customers, competitors, consultants, commercial laboratories, universities, government research organizations, other public sector, private research institutes, professional conferences, trade associations, technical/trade press, exhibitions, technical standards, health and safety standards and regulations, environmental standards and regulations. Searching widely and deeply across a variety of search channels can provide ideas and resources that help firms gain and exploit innovative opportunities.

Firms in labor-intensive clusters of Zhejiang are limited within the cluster in open innovation. We will take Yuhang home textile cluster for example. Yuhang home textile cluster has a history over 20 years. Home textile is one of the pillar industries of Yuhang. In recent years, home textile industry has grown rapidly. National industrial policy encourages the textile industry develop towards high-tech direction. Yuhang home textile industry continues to expand its scale. Firm's new investment projects are gradually increasing. However, firms in Yuhang home textile cluster are at the risk of lock-in at the low end of value chain. Firm's design idea is far behind developed countries and the products position at low-end markets. Local firms do not spend much money on R&D and design. As a result, the profit is low. In selling, because there is no local firms dominating, selling is controlled by large enterprises over seas. To break the lock-in at the low end of value chain, local firms should enhance the R&D and design capabilities. Besides, local firms should search for new knowledge at a larger range. Inbound open innovation is necessary.

71.4.2 Capital-Intensive and Technology-Intensive Industrial Clusters

Chen et al. (2011) argues that managing innovation is quite heterogeneous across industries. Jensen et al. (2007) explains this heterogeneity by distinguishing between two modes of innovation: the STI-mode (science–technology–innovation) and DUI-mode (learning by doing, using, and interacting). Science–technology–innovation is characterized by a scientific approach and is largely based on codified scientific and technical knowledge. This mode relies strongly on research and development activities in the companies. According to the intrinsic characteristics of technological innovation, firms using STI-mode of innovation have to cope with the rapid change of both technological opportunities and market conditions.

In capital-intensive and technology-intensive clusters, STI innovation mode is dominant. Firms in these clusters spend much time and money on innovating. In this situation, open innovation is critical to these firms. In the process of inbound open innovation, acquiring and sourcing is both very important. Firms are willing to buy intellectual property and technologies from outside. Meanwhile, they use open search strategy to accessing external knowledge and absorb external ideas and assess, internalize and make them fit with internal processes. Chen et al. (2011) argues that for developing STI-mode of innovations, firms should be open to particular types of partners to improve innovative performance. Vertical relations with lead users, major users, suppliers, and knowledge organizations such as universities and research institutions may be particularly important as sources of new products. In the process of outbound open innovation, many firms are not willing to sell their intellectual property or technologies to the competitors. Innovations driven by science and technology are based on R&D and scientific knowledge. Codified knowledge dominates the process of innovation. Creating and utilizing explicit knowledge plays a key role. Codified knowledge is not sticky and knowledge transfer is easy. Revealing of knowledge is therefore more probable in capital-intensive and technology-intensive clusters.

Firms in capital-intensive and technology-intensive clusters in Zhejiang are lack of outbound open innovation. We take Jiande chemical industrial cluster for example. Jiande is a traditional chemical industrial district. Jiande chemical industry includes about 69 firms. In 2010, the total industrial output is 8.66 billion. The local chemical industry was formed by the small firms with products of home-made fertilizers and pesticides. In the 1990s, Wynca Chemical Industry Group eliminated high toxicity and high pollution products and developed efficiency and low toxicity of green pesticide products. At the same time, Jiande chemical industry developed rapidly. By now, Jiande has become the largest production base of glyphosate in the world after the Monsanto. A large number of SMEs in the cluster emerged during that time.

However, because of the nature of the chemical industry, every firm's technology research and development team is lack of cooperation. Currently, research and development institutions of Jiande chemical industry are mainly concentrated in large firms. Under the concept of technology protection, large firms are reluctant to sell the technology patents. As a result, there is little cooperation between the firms in the cluster. The innovation capability of the cluster is at a low level.

To solve this problem, the firms should change their way of thinking. The failure rate of technological innovation is relatively high. Many technical achievements will not be commercialized successfully. Firms usually have redundant technology inside. Then firms can commercialize their technology externally by selling or licensing. As a result, firms not only get economic returns, but also enhance its embeddedness in the innovation network by improve inter-organizational trust and information sharing process. And firms' innovation performance will rise. However, not all the redundant technology should be externally commercialized. Firms should protect their core technology which is critical to their competitive position in the industry.

71.5 Conclusion

In this study, we focus on the impact of the inbound and outbound open innovation on innovative performance in firms of industrial clusters. More particularly, we discuss open innovation in firms from labor-intensive, capital-intensive and technology-intensive industrial clusters, respectively. We argue that firms with higher levels of absorptive capacity manage external knowledge flows more efficiently, stimulate innovative outcomes and thus obtain competitive advantage. And in a cluster with more trust between the firms, firms will achieve higher innovative performance through outbound open innovation. What's more, sourcing and revealing are more popular than acquiring and selling in firms of labor-intensive clusters. However, acquiring and sourcing is both very important while revealing is more popular than selling in firms of capital-intensive and technology-intensive clusters.

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Chapter 72
Knowledge Supply Chain and Enterprise Innovation Capacity

Ying-chun Song

Abstract The essence of the business competition is the competition of knowledge innovation, to maintain and enhance the competitive advantage of enterprises must be based on improving enterprise innovation capacity. Referring to the thought of material supply chain, building knowledge supply chain can effectively eliminate the gap between enterprises and universities and research institutions, optimize knowledge flow, enhance enterprise innovation ability in the process of the knowledge formation, development, transfer and application, so enterprises can maintain and enhance their competitive advantage.

Keywords Knowledge flow · Knowledge supply chain (KSC) · Enterprise innovation ability

72.1 Introduction

The essence of the competition is the competition of knowledge innovation (Li and Xuan 2006). With the knowledge increasing in the development of economy, the competition between enterprises has been changed from the product to the knowledge and technology-driven competition; organization operation which their core is the knowledge and value flow attracts more and more people attention. Knowledge supply chain as an important research field of the knowledge management combines the idea of systematic thinking and supply chain management, provides a new way of thinking to add value in the knowledge transferring and enhance enterprise innovation capacity.

Y. Song (✉)
Business School of Shandong University, No.180 West Culture Road,
264209 Weihai, China
e-mail: songyingchun@sdu.edu.cn

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72.2 KSC and Knowledge Flow

Knowledge is the source of technological development, new knowledge is the enterprise's unique source to maintain a competitive advantage, it is the basis of the technology innovation, productivity enhancing and the customer need meeting (Foss 2007).

Knowledge supply chain(KSC) means, around one core subject, oriented towards customer needs, through activities of knowledge flow that is knowledge innovation, connect the knowledge suppliers, innovators and users with each other, centralize and systematize knowledge advantage of the different subjects, in order to provide information and methods for enterprises to improve business operation benefit and innovation capacity (Wang 2009). Universities and research institutions themselves are producers of knowledge, and enterprises are end-users of knowledge supply chain, through the joint of the production and research, each achieve their goals effectively in the process of achieving the common market objectives. In this way, it will promote technical and economic development with sharing benefits. Application of mature experience accumulated by the enterprises in the materials supply chain management to knowledge flow management, forming knowledge supply chain, can effectively enhance enterprise innovation capability. Knowledge flow refers to the knowledge formation, development, transfer and application.

72.2.1 The Formation of Knowledge

Knowledge formation is the process of creating and discovering new knowledge (Chen and Yue 2004). The scientific research result of the technology research and development is a typical way to the formation of new knowledge and the accumulating experience of the members from different departments and posts within the organization in the activities of participating in organizations is another way to form new knowledge. At this stage, the new knowledge may only be a few elements, has not yet formed an available technology or product, so it is called "indigenous knowledge".

72.2.2 The Development of Knowledge

Knowledge development is a process of deep processing of the indigenous knowledge to make it become an identifiable, transferable and transmissible finished product (Jie et al. 2006). For example, the members of the organization make their indigenous knowledge formed in the processes of working conceptual, logical, systematic, expressed in the standard and clear words, so that other people can understand and apply it. This developed knowledge can be seen as a "knowledge products", the difference between the knowledge products and the indigenous knowledge is the maturity degree of the knowledge, the development process can make knowledge from imperfect to perfect.

72.2.3 The Transformation of Knowledge

Knowledge transformation is a transformation or dissemination of knowledge in different ways, which make other people able to absorb new knowledge and effectively use it Li (2007). The knowledge transformation or dissemination ways include enterprise organization internal AC, training, cooperation between enterprises and producers of knowledge, their essence is "an knowledge trade and knowledge products occupation", has a directly or indirectly commercial nature, which determines that enterprises should pay attention to take appropriate incentive mechanism in the process of business activities, make every member has enough enthusiasm to participate in implementation of enterprise target, to realize the "commitment" that individuals make to their organization.

72.2.4 The Application of Knowledge

Knowledge application is the process of apply knowledge to meet the objective requirements (Wu and Zhang 2007). Sometimes, new knowledge is the final product, but in most cases, only synthesize new knowledge and the existing knowledge can produce new technologies, new products and services, the essence of knowledge application can be seen as a "consumption and investment in knowledge", through the application of knowledge to obtain greater returns. If the application does not completely meet the customers' demand or desire, all or part of the above process will be repeated.

The process of the knowledge formation, development, transformation and application of is not isolated, but closely contacted with each other. In general, for a relatively simple invention, the process includes only one person or a group as a whole, then the knowledge flow of this technical innovation is continuous; but when the innovation refers to a wider range, having a great applications foreground and many users, in most cases, the knowledge system integration degree is very poor. Because each department (or innovative stage) tends to regard their work as "final product", lack of common goals, this is a passive, promotion activity. And it is this old-fashioned, isolated, fragmented concept leads to a low level of commercialization of the research results, technology innovation lagging, and inability of turning knowledge into productivity. If enterprises want to promote technical innovation effectively, they should establish a continuous flow of knowledge; transfer the pushing technological innovation activities into the market demand technological innovation activities.

72.3 From Material Supply Chain to KSC

The goal of establishing material supply chain is to enable enterprises to improve the quality and functionality of the final product through total quality management and time management, reduce total cost, shorten production cycle and delivery cycle to quickly launch new products, so that all members will jump out from narrow vision and activities, make greater contributions as a whole, and share more interest (Ma and Lin 2005). To achieve this goal, all the links and process in material supply chain should be seen as a continuous, integrated system to manage. Its main principles is: (a) material supply chain is a continuous and integrated system; (b) run in accordance with the formation of an integrated product set oriented by end-user demand; (c) each member of the chain can share benefit; (d) protect information flow and knowledge flow smoothly, eliminate barriers and misunderstanding; (e) utilize and integrate each member's expertise to optimize the entire process; (f) test products in accordance with clearly defined requirements.

Knowledge supply chain is different from the material supply chain; it is abstract, dynamic and complex. But in the production process the value of knowledge is constantly processed and value-added as same as material resources. This determines knowledge supply chain and material supply chain have much in common: (a) they both have different stages of the production, development, transfer and application; (b) begin with the concept (or imagined), through the increase of the added value to formulate output, which is product and knowledge that can be used; (c) Needs to transfer from the concept (or imagined) to a status that users could consume; (d) in the value-added process rely on continuous, effective and complete information and knowledge flows; (e) typically involves a number of different individuals, departments, or units. This similarity allows us to apply the principles of material supply chain management to the management of the knowledge supply chain, to accelerate development of technology innovation.

Reference to material supply chain management, the main management principles of knowledge supply chain is as follows: (a) technology innovation is an integrated system, needs close tie and coordination of all sector to play their maximum role; (b) each sector and member of the chain understand which knowledge can meet end-user needs, and different features and formation of knowledge transformation, who is end-user, when they need using this knowledge; (c) information flow is open to every link in the knowledge supply chain, each link understands how to make the knowledge supply chain realize the maximum value-added, and take into practice; (d) establish feedback between the knowledge suppliers and users, make information exchange more effective; (e) each link can feel the system and share it benefit, realizing that itself is an indispensable and important link in the chain.

72.4 Effective Ways to Build the KSC

As successful experience to combine technology with economy in the world today, the learning with production and research cooperation is the best way of transforming scientific and technological achievements into the productivity (Xia et al. 2012). In the process of technological innovation, universities, research institutes, enterprises are playing different roles. Universities produce some certain knowledge products, but enterprises need the knowledge products and service with use value, from the view of current situation, they have not been established up the close contact with each other, exist some gaps and barriers (Zhang and Ye 2007). For example, only when enterprises have problems in production, will they contact with Universities, and Universities themselves for impulse of "income-generating" want to contact with enterprises practical activities, but often find no "market". To build knowledge supply chain, we can refer to the experience of the material supply chain management, realize real joint of the learning with production and research, and gain the similar social and economic benefits as the material supply chain. Its knowledge supply chain management model as Fig. 72.1.

From Fig. 72.1, we can see that universities is the main producer of knowledge, turn indigenous knowledge into new knowledge to meet the production needs, and then transfer to employees or provide services to enterprises. Employees apply new knowledge in the production, and develop new products or processes. On the other hand, universities convey new talents to enterprises through training, to help enterprises improve learning ability or competitiveness.

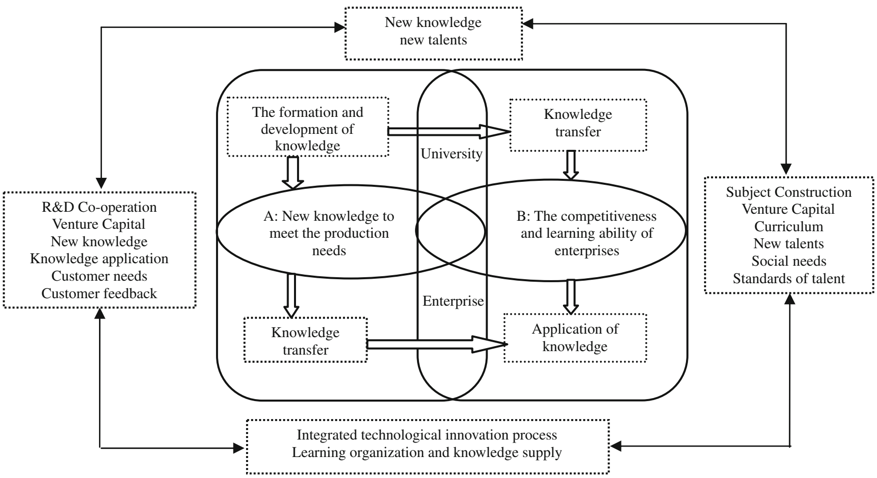

Fig. 72.1 Research combined knowledge of supply chain model

72.5 The Basic Steps for Building KSC

KSC is a tool to integrate the existing activities that is relented to technology innovation. Just as material supply chain, knowledge supply chain establishment does not need to start from scratch, all elements are already there, but these elements are isolated at present. The role of knowledge supply chain is that bringing limited links together, making contribution in specific areas of knowledge around one limited objective. Therefore, the establishment only needs to update concepts, unify their thinking, sign a cooperation agreement, and coordinate relationships and interests.

KSC, after all, is a new concept, its establishment should be generally seen with system concepts of technological innovation projects, start with solving specific problems, create and accumulate experience to be successful. Knowledge supply chain should therefore follow a five-step process: (a) clear specific content and form of knowledge which user requires, first of all provide a supply chain between knowledge suppliers and users; (b) identify the obstacles and find solutions which influence the knowledge supply chain establishment. For example, enterprises often think universities are out of practice, universities think enterprises ignore the value of intangible assets, investment is too small and the commercialization requirements too high; (c) confirm the basic principles of supply chain management fully used, in particular solidarity, mutual understanding, establishing common objectives, sharing risks and interests; (d) identify whether the initial supply chain is able to meet the needs or not, if it can't, extend to a third knowledge provider. For example, when universities can only provide the indigenous knowledge, then we need a broker transform indigenous knowledge into knowledge products; (e) when all the links are satisfied, make the knowledge supply chain standard, form a relatively fixed union, and share experience with other knowledge supply chains.

72.6 Two Basic Principles of KSC Operations

72.6.1 All Participants for the End-users

Clearing who are the end-users is one of the important principles of knowledge supply chain success. Because only the end-users can come up with the ultimate goal, establish the criteria to measure the entire process, find focus, drive the entire process and evaluate the implementation result (Li et al. 2001). To be further defined: who are the representatives of end users? Who is going to determine the "knowledge product specifications"? What criteria should follow when exchanging knowledge? Who will determine whether meet these specifications?

Facing the end-users does not deny participant benefit, but rather an affirmation, and it is the only way to guarantee participant benefit continues. Responsibility of the end-users is to make the entire system focus on a unified and clear objectives, each participant will naturally try to achieve their own goals and use the part instead of the whole. In order to make knowledge supply chain successful and sustainable, enterprises should ensure that each of the participating organizations and individuals can benefit from it. First of all, for enterprises, meet their business needs (through the introduction of new talent and technology to increase profits, reduce costs, increase efficiency and shorten cycle), and enhance their labor flexibility. Second, individual should get real and potential economic return, such as cash income, access to lifelong employment due to the knowledge and capacity improvement, opportunities for further education and improving qualifications in the process of building knowledge supply chain. Finally, universities are not necessarily limited to the obvious economic benefits, in the process of the establishment and operation of the supply chain, enterprises and universities may achieve mutual benefit through the following areas of cooperation: (a) Universities transfer related knowledge to enterprises will greatly enhance the competitiveness of enterprises; (b) the enterprises put scientific and technological achievements of the universities in production test and feedback the availability and the value of the new knowledge to researchers; (c) researchers After understanding the availability and value of new knowledge, researchers take further improvements and innovations to meet all requirements of the end-users; (d) universities help enterprises to establish a system of further education, make the workers of different levels be able constantly to raise their knowledge level, and then accumulate the intellectual capital for the enterprise; (e) enterprises provides long term support for universities in terms of resources and their laboratory construction.

72.6.2 Promote the Flow of Knowledge and Information

Compared with material supply chain, knowledge supply chain is characterized as including more different kinds of units and entities. In order to ensure the smooth flow of information and knowledge, partners should understand each other, sincerely cooperate, accept and participate in such diverse union.

Enterprises and universities are different in character and task, inevitably there are differences and gaps between them. On one hand, scientific research project of the universities is mainly funded by the government, their outcome is often indigenous knowledge. Because they are not funded by the enterprise, it's hard to truly provide knowledge products available for enterprise. On the other hand, the enterprise highlights short-term effects, does not fully recognize the importance and urgency of knowledge for competitiveness, is lack of the long-term strategy, considers that theory is far from practice, not willing to invest in long term projects. So they are lack of exchange of information and knowledge, lack of understanding and mutual support. In order to change this situation, enterprises and universities need to work together. Enterprises must understand that knowledge is an important production resource, they should always send their problems and the urgent need of technical knowledge in the production to the University. And universities should listen carefully to the enterprises (especially the end user), regard the needs of the enterprise as the goal of scientific research work, and provide high quality knowledge products.

Establishment of knowledge supply chain is not to turn universities into enterprises, or turn enterprises into universities, their tasks are different, and the goal of the knowledge supply chain is to better serve each other, make use of their own advantages, through the practical use and commercialization of the scientific and technological achievements to make them gain more benefit. To achieve this goal, they should improve the limited joint mechanism of the economy and the technology which enterprises only promote scientific and technological achievements to the enterprises, establish knowledge supply chain, in accordance with the actual needs of the enterprise to form a stimulating scientific mechanism. It means to turn the knowledge supply process into an integrated, closely linked chain, so that the process turns from disordered to ordered, and intermit into a continuous flow, make all of the partners can provide better services for the entire process according to their required time and place, while ensure their interests. Ultimately customers can gain intangible knowledge, service, and tangible products.

In the two above principles, “participants are for end-users” is the soil that all links of the chain survive and achieve self-interest, “promote the flow of information and knowledge” is the water of life for the survival and development of the knowledge supply chain. Only do a “soil and water conservation”, can knowledge supply chain develop healthily.

72.7 Conclusion

Through reference and absorption of essential thought of material supply chain, following the principles of “all participants are end-user-oriented” and “promote information and knowledge flow”, taking effective steps, actualizing the joint of the learning with production and research, constructing the knowledge supply chain, enterprises can, contact with other knowledge subjects, eliminate barriers, strengthen cooperation, optimize knowledge flow, and make itself innovation ability continually enhanced in the links of the knowledge formation, knowledge development, knowledge transfer and knowledge application.

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Chapter 73
Absorptive Capacity and Enterprise Modular Reconstruction—Perspectives Based on Open Innovation

Ying-chun Song

Abstract Organizational structure is a key factor which determine absorptive capacity and thus influence open innovation, the late studies ignored this. Open innovation requires enterprises to reconstruct the traditional hierarchy organization, achieve the knowledge and decision-making powers match, create a good organizational base and enhance the absorption capacity. Enterprises modular reconstruction whose main content is competency element modular and organizational structure modular, not only can give full play to core competencies and absorptive capacity embedded in each module, effectively acquire, accumulate, absorb and integrate the internal and external innovative resources, and can form a modular innovation networks, and then become a effective platform for open innovation to enhance its efficient.

Keywords Absorptive capacity · Open innovation · Organization reconstruction · Modularity

73.1 Introduction

Organizational absorptive capacity is one of the research focuses in the study of open innovation. However, the existing studies have not seen the organizational foundation change brought about by the open innovation ignored enterprises organizational change function to their absorptive capacity. Based on the Elaboration which the absorptive capacity is the key factor the to the open innovation success. This paper claims that reform organization to match the knowledge and decision-making powers is the basic requirement to enhance the absorptive

Y. Song (✉)
Business School of Shandong University, No.180 West Culture Road, 264209 Weihai, China
e-mail: songyingchun@sdu.edu.cn

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capacity. On this basis, this paper proposes some issues such as the organization modular reconstruction to achieve the knowledge and the decision-making power match, enhancing the absorptive capacity and improving the innovation efficiency.

73.2 Absorptive Capacity: The Key to the Open Innovation Success

In a closed innovation model (Chesbrough 2005), the enterprises obtain technical advantages by independent research and development, build a rigorous technical barriers, and thus become a monopoly on the market. This innovative model emphasis too much on self research and development, which on one hand, leads the enterprises that cannot afford the R&D investment to losing its competitive advantage for barriers of new technology; on the other hand, a lot of technology cannot turn into the enterprises core profit because of over-exploitation or separation from market demand.

In the open innovation model, enterprises treat external resources as important as internal resources, integrate resources in a larger range, constitute a new innovative ecosystem with their business environment, and greatly promote the innovation activities: (a) enterprises can introduce external new ideas to increase the innovation basic material; (b) outputting the creativity and innovation results is a good way to increase financial returns and keep creative capacities; (c) commercial development-oriented open innovation provide an efficient way for the company to measure the true value of innovation; (d) by constantly input and output creativity, enterprises identify their core competencies and make full use of their competitive advantage.

The core idea of open innovation is to build a wide and solid association with both external and internal knowledge nodes and make full use of knowledge resources. Absorptive capacity of enterprises is an important factor to achieve this goal. Absorptive capacity is a dynamic capability that how the enterprises learn and use of external knowledge; absorptive capacity is a dynamic, continuous feedback process, including five aspects: value cognition, knowledge acquisition, digestion, integration, and knowledge utilization. The stronger is the absorptive capacity, the better for enterprises is to utilize external resources and conduct open innovation. Further, open innovation improves the absorptive capacity. Therefore, enhancing absorptive capacity becomes the key to the implementation of the open innovation.

In addition to the accumulation of relative knowledge, the effort to develop absorptive capacity, the environment and other factors, the conditions of their own organizational structure and its position in the network organization are important factors to determine the absorptive capacity of enterprises. First, the basic structure of the enterprises whose main content is enterprises organization form can foster the contribution to the efficiency on the whole enterprise scale, promote collaboration between different functions in the pursuit of efficiency (Hill et al. 2007). Second, if a business unit occupies a central position in enterprises internal business network, it is easier to contact and obtain the knowledge of other business units, and then its level of absorptive capacity is higher (Tsai 2001). Finally, different alliance structures have different effect to the enterprises absorptive capacity: the horizontal complementary structure mainly helps to expand the range of knowledge, the vertical structure mainly helps to improve the depth of knowledge (Zhang and Liu 2003).

73.3 The Match of Knowledge and Decision-Making Power: Organization Basis to Enhance Absorptive Capacity

The traditional hierarchical organization is the product of the industrial revolution. In the knowledge economy age, the knowledge accumulation and innovation is the competition focus, the knowledge replace capital and energy become the primary wealth-creating assets, just as capital and energy replacing land and labor three hundred years ago. The hierarchical organization born in the industrial age is difficult to adapt to the requirements of innovation and competition in the knowledge economy age. First, knowledge is expressed as personal knowledge, especially for individuals, the majority of knowledge come into being under specific time and specific situation, has significant dependence on the situation. The situation is difficult to reproduce, so knowledge with dependence of the situation is difficult for others to understand and master (Li and Lin 2007). The effective flow of knowledge is difficult to achieve through commands, especially when the organization needs to acquire knowledge from the employees or groups at the forefront of the market to obtain advantages, the traditional hierarchical system is more powerless. Second, with the increasing of tacit knowledge, knowledge is more difficult to transfer, it is difficult to separate knowledge from its holders, while the knowledge workers scatter in various departments in the organization, these factors have led to the problem that the hierarchical organization of knowledge and power does not match even worse.

There are two options to solve the mismatch of the knowledge and decision power. First is decentralization strategy, that is transferring decision-making power to the people who have knowledge. If we do it, we will face agency cost arising from the principal-agent relationship. Second is centralized strategy, that is transferring knowledge to the people with decision-making power, so we will face information cost caused by phenomena such as lack of information, poor information, information overloading and information delaying. Generally speaking, with the increasing degree of centralization, information cost increase while the agency cost decrease; with the increasing degree of decentralization, information cost decrease while agency cost increase. Information cost and agency cost constitute the total cost of organization. According to such as the size of organization, information technology, the speed of environmental changing, government regulations and control technology and other factors, enterprises should measure information cost and agency cost on the trade-off, and re-design the organizational structure (Jensen and Macklin 1999). In the knowledge economy and information economy era, decentralization strategy is more effective than centralized strategy. More companies choose to decentralize the traditional hierarchical system.

In traditional hierarchical enterprises, the internal linear command limits the execution autonomy, meticulous division leads to workers having a narrow range of knowledge, the formal relationship limits communication between members. In order to facilitate and promote organizational learning and knowledge innovation, enterprise must transform the existing hierarchical organization with network structure, making grass-roots level organization into a node with considerable autonomy in the network (Chen 2002). Under the mission, these nodes independently choose the method of organizing activities and maintain all forms of contact, competition and cooperation with other nodes inside and outside the organization. In this network organization, levels support the orderly activities of organization, while the network promotes members of every node in the network on individual learning and sharing their knowledge that has been formed. To transform traditional hierarchical system with network structure requires enterprises to redefine their mission, make strategy, regard internal and external resources as the equality in its growth and development, carefully analyze the core advantage of each department and its contribution to the whole organization performance, redefine the roles, responsibilities, rights, and their mutual communication and coordination methods between each department.

73.4 Enterprises Modular Reconstruction: Strategy to Enhance Absorptive Capacity

A valuable organizational structure not only reduces and solves the interdependence problems, but also provide the chance for other organizations to contribute their professional knowledge for the system establishment; it is also able to create continuous opportunities and design a suitable value chain for the enterprise; allow enterprise compete with other enterprises in the eco-system as well as maintain cooperative relationships with each other (Chesbrough 2005). Using a modularity approach to reconstruct enterprises network organization just fits this requirement. Modularity as an effective method to manage complex systems is applied in more and more occasions, to enhance the modularity of the system becomes a general strategy to manage complex things (Langlois 2002).

73.4.1 Capacity Factor Modularity

The value chain is composed of many single capability factors. The factor that affects the enterprises' success or not is their capacity factor and the state of their optimal combination, rather than a specific business unit. The advantage of business unit just is the result of the combined effect of capacity factor, not the real source of the enterprises value. Enterprises should pursuit the real source of value creation from the perspective of capacity factor and separate these elements from the value chain use a modularity method make they become self-organization business entities to maximize their core competencies, achieve customer service and upgrade enterprises value (Liang 2008). The main elements of the enterprises capabilities consist of product development, design, manufacture, distribution, market network management, modular processing to these capacity factors include: (a) focus on a single capacity factor to maximum excavate the potential value of the capacity factor through centralized strategy, make it modularity and independent, turn it into enterprises business element and commercialization; (b) through spin-off strategy, by outsourcing, strategic alliances or virtual enterprise and other forms of cooperation, operate in a market-oriented direction, acquire or combine some related capacity factors, rather than combine the entire enterprise, pursuit cooperation effect, improve the enterprises competitiveness.

73.5 Organization Structure Modularity

Organizational structure modularity divides an organization into several relatively independent modular units, discards their original administrative relations, make market mechanism whose transaction relies on contract. If a module needs some kind of product or service, after the information given by the coordination center, many modular organization in the market will put forward their own bidding for its selection, based on their skills, transactions record, the difficult of the products or services to obtain, competitive dynamics and other factors. When a capacity factor module has no longer an advantage within the range of the organization's integrate resources, the organization will seek both inside and outside the enterprise for new module to replace it.

In general, the organizational structure modularity contains horizontal modular (functional unit modularity) and vertical structure (business unit modularity). Functional unit modularity manage business functions activities through outsourcing and other means, which on the surface is a function recombinant, its deeper significance is the integration between the enterprise and market. Business unit modularity is to re-optimize and combine the gene of various capacity factors to form a capacity genome with strong competitive advantages, which will make the enterprises get more centralized and unique in the aspects as knowledge accumulation and innovation, resource aggregation, information processing, product production, customer service and value creation and thus redefine or innovate the business model.

Completing organization structure modularity, dynamical adjustment on the capacity factor can be done the same as building-block, so that enterprises can focus on the business with great market potential, find profit leverage and come out the effective strategies to create more economic value. Meanwhile, the authority order coordination under the original hierarchical system is replaced by market mechanisms, the units within the enterprise transform from "was organized" to "self-organization", begin to dig and use their internal tacit knowledge, initiatively seek exchange and interaction knowledge and information with the outside, accumulate and innovate knowledge continuously. That is to say, each module manages as self-organizing, self-innovation and self-development need not external commands and becomes self-survival and self-evolution economic entities, an active promoter and practitioner of the open innovation.

73.6 Modularity Innovation Network: Effective Platform of the Open Innovation

After have achieved capacity factor and organizational structure modularity, different enterprises begin to connect with each other, and gradually form an open inter-enterprise value and innovative modularity network. Based on modularity innovation network, the information exchanges and transfers become more smoothly in innovation activities, and knowledge sharing and innovation become more efficient and the enterprises absorption capacity will be greatly enhanced. First, each internal capability factor operate modularity, and then make their core competencies more refined, deeper, and stronger, and break the physical boundaries of space and enterprise organizations through communication with the external market, make full use of the core strengths of other modular units to expand and strengthen its core competencies. Second, the modularity network will help companies more efficiently capture external information, and it is an effective organization for enterprises acquire a variety of knowledge resources. With the support of modularity network, enterprises entire business originally done by a single enterprises is now divided into several parts which will be done by the modules in the network, since each modular having different core competencies directly face to market, it is very sensitive to variety of information relevant to its operations, the breadth and depth of information gathering are increased considerably, and can efficiently make accurate judgments on the source and processing methods of information. Third, the loosely coupled features of the modularity innovation network can effectively reduce the risk of opportunism, and realize the network overall performance under the conditions of ensuring all nodes interest, it can not only improves specific innovation system flexibility and scalability (Dang and Zhang 2005), but also upgrade the reusability of each innovation nodes, since as an independent node the modularity organization often can be embedded multiple open innovation network.

73.7 Conclusion

The absorption capacity is the critical factor to success for the open innovation. To achieve the match of the knowledge and decision-making power is the organizational foundation to enhance the absorptive capacity. The enterprises make modular reconfiguration of the traditional hierarchical organizational structure whose main content is ability element and organization structure can realize the match of the knowledge and the decision-making power, enhance absorptive capacity and make full use of the core competencies embedded in each modularity, help enterprises to integrate into the open modular innovation network to improve the enterprises open innovation efficiency.

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Chapter 74
Research on the Reverse Knowledge Transfer Mechanism Through the Overseas M&A of China's Companies: Based on the BSC Ideology

Yuan Wang and Xiao Zhao

Abstract Increasingly, the geographically dispersed subsidiaries begin to transfer knowledge to their headquarters. Meanwhile, more and more China's companies go abroad and also face the problems of reverse knowledge transfer (RKT). Therefore, this paper explores the mechanism of RKT from the subsidiaries abroad to the parent companies at home. Based on the balanced scorecard (BSC), this paper presents the objects and variables in the perspective of financial, customer, internal business and innovation and learning in order to make the RKT process more successfully.

Keywords Reverse knowledge transfer · Overseas M&A · BSC · PDCA cycle

74.1 Introduction

According to a survey, the number of M&A activities all over the world was 22.9 % higher in 2010 than in 2009. To date, the emerging economies have completed one third of M&A events globally. M&A can provide the parent companies with R&D technologies, management experience and brand recognition quickly. However, the success of these goals is not very easy because the process of the knowledge transfer would be affected by some factors such as the M&A bodies, culture differences, organizational context and so on. At present, the literature of knowledge transfer almost focus on the key factors and model (mechanism) of knowledge transfer from the parent companies to their subsidiaries, across the strategic alliance or during the university-industry collaboration. For example, Duan et al. (Duan et al. 2010) empirically explored and verified ten key factors affecting knowledge transfer success, including relationship, culture awareness, language, motivation,

Y. Wang (✉) · X. Zhao
School of Management and Economy, Tianjin University, Tianjin, China
e-mail: yuanw@vip.sina.com

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knowledge distance, objectives and focus, transfer channel, selection of appreciate partners, trust and openness (Duan et al. 2010). In addition, Wang et al. (2004) developed a two-stage model describing knowledge transfer from MNCs to their China subsidiaries (Wang and Tong 2004).

However, the direction of knowledge transfer is changing. Increasingly, geographically dispersed subsidiaries begin to function as neural networks, reverse transferring knowledge to headquarters. We find that there is little work that attempts to examine the reverse knowledge transfer (RKT), especially the RKT through the overseas M&A of China's companies.

74.2 Literature Review

Hakanson and Nobel (2001) focused their study on the effect of local embeddedness and integration on reverse technology transfer, and then concluded that both of the factors increase the propensity of reverse technology transfer (Hakanson and Nobel 2001). Schlegelmilch and Chini (2003) offered a dynamic view of the conceptual model of RKT including strategic mandate of the subsidiary, value of knowledge stock, cultural distance, knowledge transfer capabilities and organizational distance (Schlegelmilch and Chini 2003). After exploring the impact of R&D projects on reverse knowledge integration, Frost and Zhou (2005) found the positive association between them (Frost and Zhou 2005). As for the variables affecting the benefits from the RKT, Ambos et al. (2006) examined the competitive strength of the host country, subsidiary strategic mandate and absorptive capacity of the headquarters (Ambos et al. 2006). Piscitello and Rabbiosi (2006) investigated how the impact of RKT on parent's innovativeness would be greater, and their significant findings included that person-based mechanisms are employed, subsidiaries are competence-creating and knowledge creation benefits from local external linkages (Piscitello and Rabbiosi 2006). Persson (2006) reckoned that operational structure, knowledge sharing incentives and subsidiary socialization, liaison mechanisms and temporary teams have a positive influence on outbound knowledge transfer (Persson 2006). Larissa Rabbiosi (2011) found two distinctive configurations that positively affect the extent of RKT (Rabbiosi 2011).

In a word, the literature abroad usually shed light on the factors, models, the impacts of RKT and so on. At home, there are also some people paying attention to these aspects. For example, Jinsheng and Guoxu (2006) came up with five key factors through modeling the RKT process, including the value of knowledge stock of the subsidiaries, the transfer willingness and capacity of the subsidiaries, the control mechanism and the absorptive capacity of the headquarters (Jinsheng and Guoxu 2006). In addition, some domestic scholars also noted the RKT of the China's companies that took over foreign ones. Qunxi et al. (2012) applied the SCP theory to explain some key variables and their relationship with the effect of RKT (Qunxi et al. 2012).

With more and more overseas M&A activities, China's companies need some researches about the RKT. Therefore, this paper explores the mechanism of RKT based on the BSC ideology.

74.3 Balanced Scorecard (BSC)

The scorecard can be used to assess activity performance of an organization based on four perspectives, namely (1) financial; (2) customer; (3) internal business; and (4) innovation and learning (Kaplan and Norton 1992). Managers should know more about the company's needs and ensure the alignment of the management processes and the long-term strategies (Kaplan and Norton 1992, 1996). The balanced scorecard put emphasis on the concept of "balance", including balancing the financial and non- financial aspects, process and outcome, the internal and external business, and the long-term and short-term goals. Kaplan and Norton (1996) summarized that the scorecard is used for (1) clarifying and updating strategies; (2) communicating strategies throughout the company; (3) aligning unit and individual goals with strategies; (4) identifying and aligning strategic initiatives; and (5) conducting periodic performance reviews to learn about the upsides and downsides for improving strategies (Kaplan and Norton 1996).

Based on the company's strategies, the balanced scorecard not only evaluates the financial outcomes in the past but also pays close attention to the intangible assets that can promote the company's development and get the potential to grow up. For the balanced scorecard's strategic guidance, this paper applies its ideology to steer the company's RKT and boost success of the process.

74.4 The Mechanism of RKT Through the Overseas M&A of China's Companies Based on BSC

The BSC system is a dynamic process that needs set goals, take action, find problems and then solve them, so PDCA cycle is the proper tool to explain the whole procedure. PDCA cycle, which stands for P (plan), D (do), C (check) and A (action), is an iterative management method used in business for the control and continuous improvement of processes and products. Its fundamental principle is iteration—once a hypothesis is confirmed, executing the cycle again will extend the knowledge further. Repeating the PDCA cycle can bring us closer to the goal, usually a perfect operation and output. Therefore, PDCA should be repeatedly implemented in spirals of increasing knowledge of the system that converge on the ultimate objects, each cycle closer than the previous. According to the analysis above, the PDCA cycle is proper to be utilized for helping complete the RKT

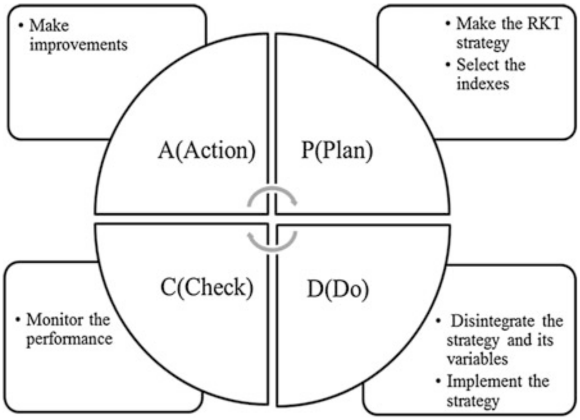

Fig. 74.1 The PDCA cycle used in RKT

process and all the variables should be guidance to make the RKT more efficient and improve the process constantly. The PDCA cycle is presented in Fig. 74.1, and the four steps and their indexes in RKT are mapped out as follows:

74.4.1 Plan

The first thing we should pay attention to is make the RKT strategy and select the indexes to measure the implementation of the strategy. In accordance with the BSC system, the whole strategy should include four aspects: financial, customer, internal business and innovation and learning.

The financial index can reflect the previous performance intuitively, simultaneously, we can make financial subjects and goals to adjust the company's strategy. At present, most companies abroad and at home make efforts to maximize the shareholder value. From this perspective, the first variable we choose is net profit of the next years after the M&A. Secondly, owing to the economy crisis in 2008 and the euro-area sovereign debt crisis, some great companies abroad can't make ends meet, which is a good opportunity for China's corporations to get the advanced technology and management experience. Under these conditions, the parent companies should try their best to make the subsidiaries turn loss into gain or achieve durable growth. The sales revenue is the proper variable to measure this object. Both of the two indexes reflect the subsidiary's growth strategy, however, another key subject which should not be omitted is the asset integration strategy. After signing the agreement of M&A, the most important thing is integration. The assets in headquarters and subsidiaries need to be integrated to maximum the use of them, including real and intangible assets. Thus, the total assets turnover cannot be more appropriate as the measuring tool.

As for the company's customers, our research divides them into external customers and internal ones. Most companies at home engaged in getting more excellent external performance through the overseas M&A, so that two main objects in this aspect are to improve customer satisfaction degree and increase their market share with a more famous brand. Obviously, the indicators we would measure are the external customers' satisfaction degree and the market share. Nowadays, the internal customers in an organization are getting more and more crucial, especially in cross-border organizations. It is empirically proved that multinational corporations (MNCs) with greater collaboration experience would capture higher levels of collaborative know-how compared to firms without it. Such know-how and experience are firm-specific internal resources which may improve an organization's ability to transfer knowledge and technology to another firm (Park 2011). In view of this, to enhance the teamwork skills should be involved in the objectives, including the teamwork between individuals, groups and so on. This object can be measured by the effects of every teamwork activity. In addition, owing to the contradiction psychology, the subsidiary which was more competent than China's headquarters and now is taken over would not be willing to transfer their technology and management experience, so this paper examines it and takes it as an object to guide the organization to improve the subsidiary's satisfaction.

The third perspective we should pay attention to is internal business, which is a crucial factor including the strategy about the organizational structure, the cultural differences and the coordination mechanism. Firstly, Luo Xuan (2006) summarized that M&A is an evolving process from adaption to collaboration for both subsidiary and the parent company (Luo Xuan 2006). With the economy developing, more and more MNCs turned into network structure oriented by globalization because this kind of structure is convenient for the expatriates and the collaboration between individuals and groups. Therefore, the determinant measuring this object should be a dummy variable, that is to say, if the structure is good for RKT, we can regard it as 1, and if not 0. Secondly, the merger and acquisition across the country border would be affected by the cultural distance inevitably. Armed with a large database of cultural statistics, Hofstede analyzed the results and found clear patterns of similarity and difference amid the responses along four dimensions, namely power distance, individualism, uncertainty avoidance and masculinity. China's companies should engage in bridging the cultural gap with their subsidiaries by figuring out the four dimensions above. Otherwise, the cultural differences would be a barrier of the success of RKT. In this aspect, the culture distance can be regarded as the variable. Last but not least, the headquarters should improve the collaboration mechanism in order to narrow the relationship distance with their subsidiaries. A harmonious relationship can overcome the practical differences, bridge the communication differences and enable all the people to openly discuss differences in knowledge approaches (Park 2011). If the companies take it as an important object for the RKT, they will achieve the competitive edge over their rivals. For this reason, this paper chooses the difficulty of collaboration as the measurable factor.

On the basis of BSC, the dimension of innovation and learning should also be put emphasis on. After the subsidiary was taken over, the most pressing thing is building shared vision with the headquarters. The parent company and the subsidiary are often separated by time, space, culture, language and so on. Thus, their visions are not necessarily the same, which may block the RKT process. The common visions should base on existing needs, requirements and problems of the two parties involved. Another dummy variable should be used to judge whether the visions between them are the same. In addition, the capacity of the subsidiary's knowledge transfer and the absorptive capacity of the headquarters should also be taken into consideration. To the company, instead of owing the knowledge stock, the significant thing is the dynamic ability to create, share and use knowledge. All these are connected with the capacities above. In view of this, we can regard the proportion of the knowledge that be transferred and be absorbed as the variable. Another object we should shed light on is the knowledge transfer channels, such as networking events, seminars, case studies, partnership building activities, business support and exchange of personnel. It is proved that when the RKT process is completed by the individual connection, especially by the teamwork and managers, the performance of RKT would be more excellent. When people are well acquainted with each other, they set up working arrangements more easily (Park 2011). The parent companies should focus on these kinds of transfer channels and measure their performances to decide proper channels for themselves.

74.4.2 Do

The next step faced with us is to disintegrate the whole strategy and its measurable variables in order to implement the strategy better. The way of disintegration is dependent on the actual situations in the company. For example, they can divide the variables by the dimensions of region, internal business or causality.

74.4.3 Check

During the process of implementation, we should monitor the performance of each object and figure out which aspects are done well and which need instant improvements. This function should be completed by a special department, such as HR department or a branch newly and specially built for the step.

74.4.4 Action

PDCA's destination is to make this process more excellent than the previous, so if we check out some problems, all the relevant people should take action to make progress and perfect the RKT process.

74.5 Conclusion

As the reverse knowledge transfer plays a critical role in the overseas M&A, especially in China's company taking over foreign subsidiaries, this paper highlights the mechanism of RKT based on the balanced scorecard ideology. We emphasizes some objects and variables that need to be noticed, such as the growth and asset integration strategy, increasing the customers' satisfaction degree, improving the collaboration mechanism, and so on. Table 74.1 identifies all the RKT objects and variables based on BSC. According to the PDCA cycle, this paper suggests that the RKT process should obey with the principle and make constant improvements.

However, this paper is just a theoretical demonstration, and the next step we should do is to do an empirical research, including data collection, the credibility and validity test of the variables and explorative factor analysis.

Table 74.1 The objects and variables of RKT

Perspective	Strategy subjects	Strategy objects	Variables
Financial	The growth strategy	Maximize the shareholder value;	Net profit
		Turn loss to gain or make growth of the new subsidiary	The sales revenue of the new subsidiary
	The asset integration strategy	Integrate the assets of the parent company and its subsidiary	Total assets turnover
Customer	External customer	Increase the external customers' satisfaction degree;	External customers' satisfaction degree
		Increase the market share	The market share
	Internal customer	Enhance the teamwork skills;	The effects of the teamwork
		Increase the subsidiary's satisfaction degree	The subsidiary's satisfaction degree
Internal	business	The organizational structure	Optimize the organizational structure
Dummy variable			
	The cultural differences	Narrow the cultural distance	The cultural distance
	The collaboration mechanism	Improve the collaboration mechanism	The difficulty of collaboration
Innovation and	learning	Shared vision	Build shared vision
	Dummy variable		
	The capacity of knowledge transfer both parties involved	Strengthen the subsidiary's knowledge transfer ability and the parent company's absorptive ability	The proportion of the knowledge that be transferred and be absorbed
The	knowledge transfer channels	Choose efficient knowledge transfer channels	The performance of all kinds of channels

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Chapter 75
The Application of MBTI Theory in Hiring Sales Staffs

Chang Luo

Abstract In China, many small and medium-sized enterprises are not standardized in sales personnel recruiting procedures, they only tend to examine the candidates' knowledge and skills however, ignore the important psychological evaluation factors, which results to employ unsuitable staffs and come into an inefficient recruitment cycle. By the analysis using MBTI scale theory, the personality types that sales staffs entail are ESTJ or ESFJ. Setting the sales backbone's personality datum as a paradigm, applying it to the recruitment of sales staffs and pro-job trainings, can improve new employees' organizational adaptability, and their performance, increase organizational cohesive force, besides reduce turnover rates.

Keywords Application · MBTI theory · Recruitment · Sales staff

75.1 Introduction

The Myers-Briggs Type Indicator is a kind of personality test. Many scholars all over the world have been studying on it and make great success. It is widely used in many ways. For example, it can help identify effective teacher personality traits (Rushton et al. 1016), and it can help improve teams' effectiveness by individuals' training on the type of personality of team members (Varvell et al. 2004). This article mainly talks about the application of MBTI theory in hiring sales staffs, analyzing what the personality type sales staffs should be, and how to use personality test in the recruitment.

C. Luo (✉)
School of Economy and Management, North China Electric Power University, Beijing, China
e-mail: chinaluochang@126.com

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75.2 Necessity Analysis

In our country, many small and medium-sized enterprises are facing up with the status which is very difficult to obtain outstanding sales staffs. Investigating the root causes, in order to reduce recruitment costs, shorten recruitment time, and use new labor as soon as possible, many companies' sales staff recruiting procedures are not standardized, only tend to examine the candidates' knowledge and skills, and ignore factors such as mental evaluation, resulting in error appointments. Always facing vacancies, enterprises are frequent for recruitment, however, which is inefficient, still doesn't realize the people-positions matches, and ultimately go into a void recruitment cycle. Moreover, even if some companies consume a lot of recruitment costs, screen out candidates with good performance after many rounds of interviews, the new staff members in the actual work are tough to cope with difficulties, whose performances are mediocre. How to recruit suitable staffs? What kind of employees can bring about high performance?

I believe that the recruitment of sales staff focuses on the psychological evaluation. Inspection of candidates' knowledge and skills is the basis for screening out the candidates of same basic conditions, then the psychological evaluation of candidates decides who can get the final Offer. The psychological evaluation can be divided into the overall capacity assessment, dynamic assessment and personality assessment (Zhen-ning 2009). This paper mainly talks about how to recruit sales staffs effectively with the application of MBTI scales in personality assessment.

Personality is the organic combination of individual character, attitudes and habits. Personality is some characteristics of continuity, harmony and relative stability. It reflects men's inner hidden nature. Personality can be analyzed as personality characteristics and behavior tendency quantitatively that can adjust men's action stably (Qiong 2009).The analysis of high-performance employees' personality characteristics can provide reference for human resources planning. MBTI scale is one method in personality tests, and it can be put into practice in whatever kind of recruitment channels.

75.3 Brief Introduction to MBTI Theory

Myers Briggs type index (MBTI) representing men's characters, is formulated by Katherine Briggs and her daughter Isabel Briggs Myers in 1962 (McCrae and Costa 1989). The index is founded on 8 types divided by Swiss psychologist Carl Jung, and measures personal interests and personality characteristics by Four Groups of Tendency Dichotomies; each tendency dichotomy group composes of two poles (Myers et al. 1998). The so-called tendency (preference) is a kind of specific behaviors and thinking ways, with no right or wrong. They identify some normal and valuable behaviors. Considering four dimensions as four rulers, each character fells on a certain point on the scale. If it's very close to one pole, the one has preference in this regard (Myers Isabel Briggs 1970).

MBTI theory inspects personal preferences from the following four dimensions:

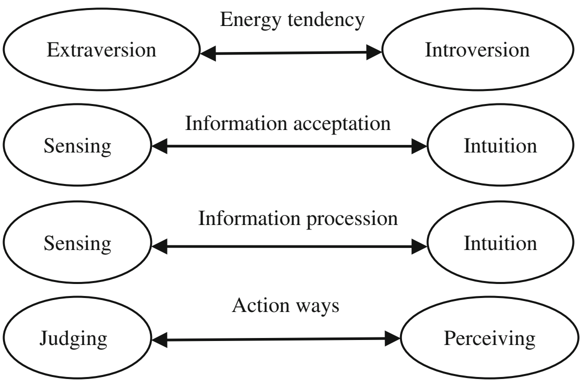
1. Energy tendency—Extraversion (E) and Introversion (I). Men belong to type E are good at expressing emotions and ideas and are much more active and motivated; men in Type I like to think in silence, and they will not show their emotions and ideas easily.
2. Information acceptation—Sensing (S) and Intuition (N). Men of Type S sense things with perception, they have outstanding observation skills and are good at memorizing for details. While men in Types N believe in the sixth sense, they predict the future following with imagination and inspiration.
3. Information procession—Thinking (T) and Feeling (F). Men in Type T are relatively objective and integrate. They have a clear mind, and will not be influenced by emotions. They like analyzing things, besides they pay much attention to the essential contacts, act in accordance with principles and norms. What the difference is that men of type F are more considerate and mercy, they care about interpersonal relationships, appreciate others, and also enjoy being praised.
4. Action ways—Judging (J) and Perceiving (P). J type people like developing in plan and organization, while P types prefer to let it slide.

MBTI scale can be seen as follow: (Fig. 75.1).

75.4 MBTI Analysis of Sales Staffs

We know that the combination of four MBTI dimensions will form sixteen different personality types. Each type has its suitable jobs. So we apply MBTI theory to enterprises' recruitment tests, figuring out job seekers' personality types, comparing their character tendencies with enterprise values, and selecting out

Fig. 75.1 MBTI scale sketch



those who fit enterprise cultures or will fit after pro-job trainings. Of course, it is inevitable that job seekers have studied the enterprise in advance and cheated in evaluations. But it's worthy of being explored the effective application of MBTI method to recruitment process which can judge job seekers' characteristic tendencies in a short time.

What kind of person is suitable for sales? After a summary of excellent sales men's character traits, we can conclude the characters a competent sales staff should possess. The author thinks that, her characters should be extraversion tendency, open, bright and optimistic. She should have certain interpersonal skills and good professional attitudes. She will not retreat confronting setbacks and rejections. What's more, she has unswerving spirit and certain ability to bear stress. Successful sales personnel are sensitive to environmental changes, they can catch words which suggest customers' subtle psychology changes and find clues, altering their offensive strategies flexibly. They will put themselves in for the sake of the customers to earn favorable impression and trust. This kind of memory for details and observation is typically what men in type S owes. People with T type personality are objective, integrate, rational and cold. When they meet with principled problems, they think the circumstances are excusable but the law cannot forgive. Sales personnel always meet with actual practice those poor quality customers who sternly refuse and even abuse in countless, they should be calm to solve the problem in a rational way, don't be swayed by emotions. Sales staffs generally desire to be encouraged by words such as "thank you" "you did great", so they will have motivation to work hard to achieve next sales target. Taking these into consideration, I think sales staffs' index in the treatment of information should lie in the middle state of thinking T and emotion F. The index very partial in anyone of the two poles indicates that she is not suitable for sales occupations on the contrary.

In respect of action ways, J type personality is suitable for sales. The enterprise's annual profit increase mainly relies on the expansion of production and the increase of sales. It's necessary that sales personnel realize enterprise sales goal bottom-up gradually in a planned way to realize enterprise's annual marketing strategy and the growth of profit margin. While P type personality prefers to experience constantly and let things slide. They are more suitable for freelancers.

To sum up, the personality types sales occupations entail are ESTJ or ESFJ assessed by MBTI scale. The assessment result can be used as the reference of personality types when recruiting sales personnel. However, the matching personality type with position is not established. What kind of personality sales staff should possess reaches no conclusion. Some do not have this kind of character features can also do very well in sales, hence the result can only play an employment reference role (Fig. 75.2).

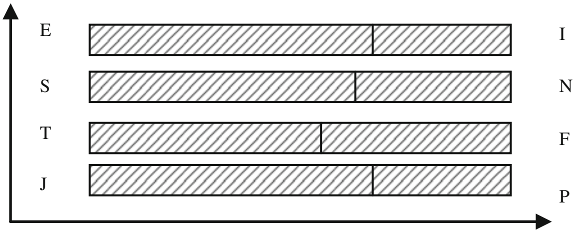


Fig. 75.2 Sales staffs' MBTI type

75.5 MBTI Scales in the Recruitment of Sales Staffs

The application of MBTI scale in the recruitment of sales staffs, firstly employees with excellent performance in sales positions should be analyzed. Compare the personality traits of the outstanding performance employees with general performance employees, analyze the datum of the paradigm, and obtain the characteristics the positions require. Then it can be used as a corporate recruiting reference.

To select the best sales staffs from a variety of channels, MBTI scale can act as an evaluation basis. Internal recruitment may unearth the talents of potential from non-sales department, in the end to utilize human resource within the enterprise to the upmost (Li 2007). For candidates who are not engaged in before and intend to do now, HR department will screen out job transforming applications of intent and communicate with relevant departments to understand the backgrounds (work records, trainings, etc.). Then they identify candidates initially, then use MBTI scales with other evaluation methods to conduct personality test, to see whether the character traits and vacancies match.

For the open recruitment process, first of all HR department should screen out the candidates' resumes. After the initial interview, a few people are allowed to do the test with the MBTI scale before the second interview. After resume screening and initial interview, the interviewers pick out candidates whose qualifications, experience, and skills meet the requirements of corporate recruitment. Those candidates are likely to eventually be hired (Guan-jun et al. 2006). The next stage evaluation focus on examining the candidates' quality, career interests, motivations, and attitudes to see whether they are consistent with the statements of work and whether their values are in accordance with the corporate values asked. The results in this stage of evaluation should account for 2/3 in the final admission factors. If the business interview process is relatively simple, personality test can be used between the interview has been over and before the final decision is made. What's more, the interviewers should explain to interviewees the reason why they are not admitted to the corporation.

In addition, the results of the MBTI scale evaluation can also serve as the basis for future training. In some enterprises, sales department takes into account that the human resources are relatively abundant, they regulate only passing through pro-job training assessment can finally mean the end of the recruitment. Sales personnel need to understand the enterprise's management concept, values, sales strategies and sales tasks in order to go on well, which are all the content included in pro-job training. Pro-job training can be classified into common training and professional training, which can be divided into several phases (Jing-sheng and Li 2011). The result of MBTI assessment can help determine what training employees are needed. In department training phase, department heads can make training plans flexibly according to different personality qualities, customizing specific training schedules for employees, to make them orient to their positions quickly and improve cohesive force of the organization and the employees' performance levels. The assessment results of MBTI scale can also be used into employees' career planning and management, helping them knowing their own advantages and disadvantages in early period, to customize career developing courses suitable for themselves, making preparation for well developed achievement period around the corner.

75.6 Conclusion

The MBTI scale is one of the personality test. Using personality test in recruitment procedure can help HR find the right person. Sales occupations personality type should be ESTJ or ESFJ assessed by MBTI scale, which is the reference when recruiting sales staffs in variable channels. It can finally improve the performance of the sales staffs, make employees feel being valued, and reduce the turnover rate.

Acknowledgments This article is the first attempt to discuss the solutions of recruiting sales staff by using MBTI scale. It will have a broad developing space in the future. Thanks for Cheng-ju QIN, a teacher of school of economy and management in North China Electric Power University. Thanks for her patient guidance and great help.

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Chapter 76
The Effect of Innovation Environment on the Equipment Manufacturing Industry in China

Xu-sheng Chen, Hong-qi Wang and Yu Gu

Abstract With the increasing impact of innovation policy, external factors affecting the industry become important in enhancing the innovation ability of firms. This paper analyzes the influence of innovation environment in the development of new products, promotion of technology innovation, and in the increase in market share. First, the paper establishes a corresponding evaluation index system according to the external factors affecting industrial innovation. Second, the paper demonstrates the performance of innovation environment through scores obtained from super to efficient data envelopment analysis (DEA), and distinguishes the degree of effects of the different factors through composite DEA. The results show that innovation support for science and technology is the most significant factor in innovation environment, and that the impact of government support on industrial innovation is the least significant. Finally, the study suggests countermeasures to improve industrial innovation.

Keywords Effect · Equipment manufacturing industry · Innovation environment · Super efficiency DEA

76.1 Introduction

Technological innovation of competitors, labor turnover among enterprises, and the increasing market demand have all enabled innovative behaviors to diffuse, and various factors such as capitals, personnel and equipments etc. to recombine within the industry, promoted changes of production and profit distribution, and resulted in the emergence of new industries (Singh 2009). However, industrial

X. Chen (✉) · H. Wang · Y. Gu
School of Management, Harbin University of Science and Technology,
Harbin, China
e-mail: zhshkslw@163.com

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innovation marks the result of mutual influence among enterprises, and the disordering trend exists in product selection, market development and technological industrialization in the innovative process. Innovative risks not only come from internal enterprises, but also serve as result of mutual influence among innovative activities of enterprises (Leiponen and Ina 2007). External environmental factors, for instance, governmental policies, financial environment, organizational innovation and market variations, can pose material influence on innovative performance of the industry.

The role of government in industrial innovation process is attracting increasing attentions, the reason of which lies in that on one hand, government of every nation has gradually realized that strategic industry has significant influence on long-term development of countries during international competition; on the other hand, it is difficult on average for enterprises to bear innovative risks, which calls for governmental support in capitals and policies. Aiming at innovation conditions, development trend and existing problems in the field of precision engineering, Watanabe emphasizes that innovation efficiency can be improved through formulating, researching and developing technology roadmap (Watanabe 2006). Despite that compared with larger enterprises, small companies prefer innovation, greater innovation risks are in existence due to limitations of scales and technological conditions. Wallsten establishes an equation with several unknowns to test and verify relationship between innovation activities of small enterprises and funding (Wallsten 2000). In addition, as maker of macro control policies in the market, government can coordinate differences between industrial development and social demands according to innovation orientation and requirements on environmental protection of the country or region it locates.

It is the main purpose of enterprises to adapt to market changes, improve product diversity and reduce production cost in innovation process, and technological industrialization time enjoys direct influence on occupying market in early phases, which enables enterprises to attach importance to short-term benefits to improve profits, and ignore technology accumulation as well as systematic training of R&D personnel, thus results in the difficulty in realization of technology innovation by leaps and bounds (Kaldor 1992). R&D of scientific institutions as well as teaching mode of colleges and universities that is catered to innovation can supplement enterprises from realizing technological breakthrough and forming innovation teams of high qualities (Hong et al. 2011). By applying triple-helix theory in an earlier phase, some Scholar propose that a synergetic mechanism among administrative departments, R&D establishments and enterprises in the nation can be formed in biology, information and communication technology etc. (Etzkowitz 2000; Leydesdorff and Meyer 2003). In accordance with analysis on formulation process of lead-free solder standard in developed countries of America, Europe and Japan etc., Masaru designs a cooperative network involving universities, industries and public departments, and determines characteristics of structures of cooperative network in promoting implementation of new technology standards and improving innovation efficiency (Yarime 2006).

Venture capital has become main source of enterprise innovation fund in developed countries. Especially that in knowledge-intensive industries, venture capital enjoys a close relationship with patent growth, technology efficiency and expansion of enterprise scales. Venture capital has become part of innovation strategies in enterprises (Peneder 2009). It is indicated in empirical study on effects that support venture capital policies of America since 1979 that increasing of venture capital can promote patent growth materially (Kortum and Lerner 2000). Based on the research of corporate relationship regarding German technical innovation and Investment Company, Weber structures conception of "relational fit", and puts forward that cooperation of both parties marks the key to promote knowledge transformation and innovation and improve organizational efficiency (Weber 2007). According to analysis on innovation models in recent 50 years, Engel proposes a new commerce innovation model formed through integration of entrepreneurial spirit, technology variation and venture capital, whose fundamental innovation, in general, surpasses technology scope and changes management method of supplying chain (Engel 2011).

FDI can not only provide capitals to development of host countries, but also promote economic development through increasing industrial employment capacity and foreign trade volume. The aforesaid influence subjects to factors of technical compatibility, market gap, and technology absorption capacity of enterprises in host country. C demonstrates that negative influence of technical overflow occupies a dominant status when there is excessively big gap in technology, and motivation of technology innovation is in proportion to network externality (Zong-Ci et al. 2011). Moreover, Wang Zong-Ci constructs two-stage Cournot model, and analyzes conditions and features of reverse overflow effect in FDI technology diffusion (Chang-qi and Ya-wei 2009). There are technological differences between foreign enterprises and those of host nations; as a result, externality and knowledge distribution of technology results in that FDI exerts direct influence on overflow of industrial innovation technology in host nations (Schneider 2005).

76.2 Methodology

1. *Performance Evaluation Based on SE-DEA*: DEA often be used to describe the behavior of innovation, and analyzes the various production input and output of between the innovation process. In practice, each enterprise prior do not know their own revenue function, and just having the observation of input–output data. So the production possibility set can be defined as followed.

$$T_j = \left\{ \left(x_j, y_j\right) \quad \sum_{k=1}^{s} x_j^k \lambda_j^k \le x_j, \sum_{k=1}^{s} y_j^k \lambda_j^k \ge y_j, \sum_{k=1}^{s} \lambda_j^k \le 1, \lambda_j^k \ge 0, k = 1, \ldots, s \right\}$$

Effective production frontier is the corresponding surface of the production function $y = f(x)$. The programming problem (P) equivalent refers to (76.1).

$$\begin{cases} \max \sum_{j=1}^{n} \alpha_j y_j \\ s.t\, f_j(x_i) \le \alpha \\ \qquad \sum_{j=1}^{n} x_j \le \alpha \\ x_j \ge 0, j = 1, \ldots, n \end{cases} \tag{76.1}$$

Following linear programming problem can be used to instead of problem $(\bar{P})$.

$$(\overline{P}) \begin{cases} \max \sum_{j=1}^{n} \alpha_j y_j \\ s.t. \sum_{k=1}^{s} x_j^k \lambda_j^k \le x_j \\ \sum_{k=1}^{s} y_j^k \lambda_j^k \ge y_j, j = 1, \ldots, n \\ \sum_{k=1}^{s} \lambda_j^s \le 1 \\ \sum_{j=1}^{s} x_j \le \alpha \\ \lambda_j^k \ge 0, k = 1, \ldots, s \\ x_j \ge 0, y_j \ge 0, j = 1, \ldots, n \end{cases} \tag{76.2}$$

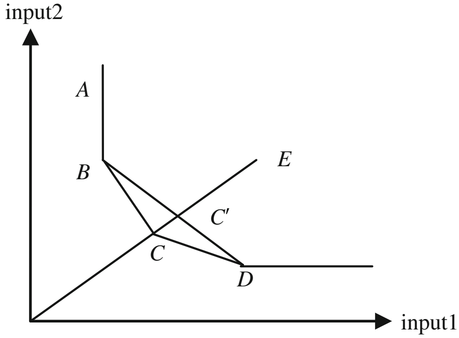
Dual problem of the problem $(\bar{P})$ refers to (76.3).

$$(\overline{D}) \begin{cases} \min u\alpha + \sum \mu \sum_{j=1}^{n} \mu_j^0 \\ \omega x_j^k - \mu_j y_j^k + \mu_j^0 \ge 0, k = 1, \ldots, s \\ \qquad u \ge \omega \\ \mu_j \ge \alpha_j, j = 1, \ldots, n \\ \mu_j^0 \ge 0, u \ge 0, \omega \ge 0, \mu_j \ge 0, j = 1, \ldots, n \end{cases} \tag{76.3}$$

We call $(\bar{P})$ and $(\bar{D})$ are non-parameter DEA model. Thus, SE-DEA model can overall distinguish efficient DMU which value of θ is 1 by CCR. The SE-DEA model can be expressed in Fig. 76.1. DUMS of efficient DEA are A, B, C, and D, DUM E is inefficient point. Among compared in efficient point, super efficient value can be obtained based on new best frontier, which the point of super efficient value be excluded from set of decision-making, for example super efficient value of point C can be calculated based on changed best frontier of ABD, its efficiency is OC′/OC>1. Since the best frontier to invalid point is still ABCD, Efficiency of efficiency value is unchanged.

2. *Index Comparison Based on Composite DEA*: DMU can be a factor in the effectiveness of the unit vector for the component $\theta(D) = (\theta_1(D_i), \ldots,$

Fig. 76.1 SE-DEA model



$\theta_n(D_i))^T$, which is obtained using the above model. Remove the first species with d_i said output indicator set. Refers to the use of in d_i DEA method, find the effectiveness of various policy unit of coefficient vector obtained $\theta(D_i)$, and can prove that $\theta(D) \geq \theta(D_i)$. Obviously, indicators are related to the efficiency value of DMU, the main influence index can be identified through efficiency change, the scores of $\theta(D_i)$ and are adapted to analyze the information of variation regularity. For the invalid DMU, the input index which affects its performances value can be studied, firstly, Invalid vectors $\theta\left(D_{j0}\right)$ should be calculated, thus, new vectors that $S_i = \left(\theta_{j0}(D) - \theta_{j0}(D_i)\right)/\theta_{j0}(D_i)$ is defined, For total influence on invalidation of DUM is computed according to (76.4), the index which has bigger influence score regard as main factor.

$$\sum S_i = \sum \left(\theta_{j0}(D) - \theta_{j0}(D_i)\right) * 100/\theta_{j0}(D_i) \tag{76.4}$$

3. *Setting up evaluation indexes*: According to the DEA model, the paper establishes the index system of inputs and outputs, there is four input indexes, which are government support degree (X_1), financial environment (X_2), service capacity of science and technology (X_3), and degree of market opening (X_4). There are three output indexes, which are the ability to development product (Y_1), level of profit of new product (Y_2), and level of technology innovation (Y_3). The formulas are expressed as followed.

X_1= government funds for S&T activities (unit: 10,000 yuan);
X_2= loans from finance institutions for S&T activities (unit: 10,000 yuan);
X_3= Intramural expenditures on S&T activities in R&D institutions by industry (unit: 10,000 yuan);
X_4= gross industrial output value of joint ventures/gross industrial output value;
Y_1= projects of new product development/projects of scientific and technological;

Y_2= sales revenue of new products enterprises/sales revenue of products in enterprises;

Y_3= the number of invention patents in enterprises

4. *Data source*: The data of empirical research are taken from China Statistical Yearbook and China Statistical Yearbook on Science and Technology (2009); according to sample requirement of DEA model, 28 industry of manufacturing industry have been selected, and data of sample is listed in Table 76.1.

Moreover, Other Countries have not proposed the concept of equipment manufacturing industries except China. This paper defined former industries which include DUM21–DUM27 in Table 76.1. Industry of culture, educational and sports goods has not data of service capacity of science and technology, so it is removed from the samples.

Table 76.1 Dum of manufacturing industry

DUM	Industry
1	Processing of food from agricultural products
2	Manufacture of foods
3	Manufacture of beverage
4	Manufacture of tobacco
5	Manufacture of textile
6	Manufacture of textile wearing apparel, foot ware and caps
7	Manufacture of leather, fur, feather and its products
8	Processing of timbers, manufacture of wood, bamboo, rattan, palm, straw
9	Manufacture of furniture
10	Manufacture of paper and paper products
11	Printing, reproduction of recording media
12	Processing of petroleum, coking, processing of nucleus fuel
13	Manufacture of chemical raw material and chemical products
14	Manufacture of medicines
15	Manufacture of chemical fiber
16	Manufacture of rubber
17	Manufacture of plastic
18	Manufacture of non-metallic mineral products
19	Manufacture and processing of ferrous metals
20	Manufacture and processing of non-ferrous metals
21	Manufacture of metal products
22	Manufacture of general purpose machinery
23	Manufacture of special purpose machinery
24	Manufacture of transport equipment
25	Manufacture of electrical machinery and equipment
26	Manufacture of communication, computer, other electronic equipment
27	Manufacture of measuring instrument, machinery for cultural and office work
28	Manufacture of artwork, other manufacture

76.3 Results

76.3.1 Result of Efficiency by CCR DEA

Scores and rank of efficiency by CCR DEA is listed in Table 76.2.

76.3.2 Result of Efficiency by SE-DEA

Scores and rank of efficiency by SE-DEA are listed in Table 76.3.

76.3.3 Result of Index Comparison Based on Composite DEA

The efficiency scores of DUM by composite DEA are listed in Table 76.4; $\theta(D_i)$ represent the efficiency scores of remove i index. Sum of changed ratio ($\sum S_i$) is listed in Table 76.5 according to formula (76.4), which comparison to equipment manufacturing industry (DUME).

76.4 Discussion

Through the calculation of the equipment manufacturing industry efficiency value, the results indicate that the efficiency value of DUM21, DUM24, DUM25 and

Table 76.2 Result of efficiency by ccr dea

DUM	Scores	Rank	DUM	Scores	Rank
DUM1	0.1019	28	DUM15	0.8000	13
DUM2	0.2631	24	DUM16	1.0000	1
DUM3	0.8259	12	DUM17	0.6264	17
DUM4	1.0000	1	DUM18	0.2339	25
DUM5	0.5377	19	DUM19	0.8401	11
DUM6	0.7700	15	DUM20	0.4300	20
DUM7	1.0000	1	DUM21	1.0000	1
DUM8	0.2169	26	DUM22	0.3583	22
DUM9	1.0000	1	DUM23	0.3506	23
DUM10	0.8732	10	DUM24	1.0000	1
DUM11	0.7144	16	DUM25	1.0000	1
DUM12	1.0000	1	DUM26	1.0000	1
DUM13	0.5454	18	DUM27	0.1613	27
DUM14	0.3802	21	DUM28	0.7916	14

Table 76.3 Result of efficiency by se-dea

DUM	Scores	New rank	DUM	Scores	New rank
DUM4	100.7284	1	DUM21	1.3531	7
DUM7	3.5720	3	DUM24	1.3062	8
DUM9	1.5419	6	DUM25	1.0709	9
DUM12	1.5956	5	DUM26	7.1645	2
DUM16	1.7809	4			

Table 76.4 Changed efficiency scores by composite dea

$\theta_{j0}(D_i)$	X_1	X_2	X_3	X_4
DUM1	0.0479	0.1019	0.1019	0.0947
DUM2	0.2631	0.2499	0.1274	0.2456
DUM3	0.8259	0.5740	0.2048	0.8259
DUM4	100.7284	100.7284	100.7284	5.8697
DUM5	0.5140	0.5377	0.2564	0.3822
DUM6	0.7683	0.7700	0.4176	0.5246
DUM7	1.8064	3.5720	2.8751	3.5720
DUM8	0.2139	0.2169	0.1845	0.1966
DUM9	1.5419	1.5419	0.3189	1.5419
DUM10	0.8732	0.8498	0.2037	0.8251
DUM11	0.7140	0.7142	0.2190	0.5415
DUM12	1.5956	1.5956	0.1812	1.5956
DUM13	0.3411	0.5454	0.5454	0.2766
DUM14	0.3356	0.3802	0.3802	0.2017
DUM15	0.8000	0.7334	0.3724	0.8000
DUM16	1.6162	1.7809	0.4546	1.7758
DUM17	0.6264	0.6105	0.2844	0.5779
DUM18	0.2339	0.2339	0.2082	0.1963
DUM19	0.7201	0.8401	0.7557	0.8328
DUM20	0.4300	0.4300	0.2708	0.3644
DUM21	1.3531	1.1333	0.2097	1.3531
DUM22	0.3095	0.3583	0.3583	0.2661
DUM23	0.3036	0.3506	0.3506	0.2554
DUM24	1.3062	1.0249	0.3715	1.3062
DUM25	1.0402	1.0709	0.7419	1.0106
DUM26	6.7431	2.2468	7.1645	7.1645
DUM27	0.1613	0.1521	0.1163	0.1613
DUM28	0.7916	0.7259	0.1165	0.6059

Table 76.5 Sum Of Changed Ratio

$\sum S$	X_1	X_2	X_3	X_4
DUME	40.4491	271.7694	879.8325	77.8929

DUM26 are reach 1.The efficiency value of DUM22 and DUM23 are located near 0.35, ranking in the entire manufacturing sector are 22nd and 23rd. The efficiency value of DUM21 is 0.1613, the position of its innovation efficiency in the entire manufacturing by comparison, ranking the 27th. The Data envelopment analysis can not give fine distinction while the efficiency values is 1, so the saving situation of input elements are adjusted by SE-DEA method, and the samples which efficiency value not to reach 1 remains. After adjustment, innovation efficiency value of DUM26 is the highest, about 7.1645. Through the analysis of the influence of innovation environment of the equipment manufacturing by composite DEA, we concluded the supporting ability of science and technology most significant impact on industrial innovation, followed by financial environment, Government support and the degree of market opening on the industrial innovation effect is weak.

76.5 Conclusion

This paper analyzes the external influences of industrial innovation on the equipment manufacturing industry in China using an index system. The index system includes government support, financial environment, support for science and technology, and the degree of market opening.

In the manufacture of communication, computer, and other electronic equipment with higher technology support capabilities and greater market-opening degree, the corresponding output indicators relating to new product development and the number of patents in the manufacturing industry are the highest. Hence, the efficiency score in the equipment manufacturing industry is the highest, which reflects the high-input and high-output feature of innovative influence. The efficiency values of manufacturing measuring instruments and machinery for cultural and office work are lowest because new sales income are lower in proportion compared with the main business. The percentage of industries with an efficiency value of 1 belongs to the equipment manufacturing industries at 57.14 %, and the proportion of efficiency value of other manufacturing industries is 23.81 %. The efficiency value is significantly lower in the other manufacturing industries compared with that in the equipment manufacturing industry.

Based on empirical research, the impact of innovation support for science and technology is the most significant. Thus, enterprises should promote mechanisms of cooperation with research institutes and universities, and use their respective advantages to develop new technologies and new products.

The equipment manufacturing industry has always been the focus of government support, but the influence of government support on the innovation of the equipment manufacturing industry is the weakest. This weak influence shows that government investment efficiency should be raised. Establishing a mechanism for financial classification, developing a number of promising projects, implementing tilt funds for key projects, and improving the dissemination of knowledge infrastructure are the main measures to improve support efficiency.

The financial environment has a lower influence on the innovation of the equipment manufacturing industry. The low influence shows that the financial system supporting industrial innovation is undeveloped in China. Enterprises should attract social capital using multi-channels such as credit, equity and bonds, circulation loan amount, small business joint guaranteed loans, corporate account overdraft, chattel mortgage, and so on.

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Chapter 77
A Study on Cluster Brand Growth Based on Five Forces

Su-ping Zhou

Abstract Cluster brand has brand identity, geographic characteristics, public goods characteristics, brand collaboration features, industrial advantages characteristic, cluster-dependent, brand effect persistence, dynamic and management Subject diversity, which plays important roles to cluster by cluster cohesive, display power, identification strength, competitive power, innovation power and profitability and trust power. The paper analyzes five forces for cluster growth, which is, cluster brand learning ability, government impetus, industry associations cohesion, clusters innovation impetus and cluster growth promoted power by each other.

Keywords Cluster brand · Five forces · Cluster brand learning ability · Government driving force · Industry association cohesion · Cluster innovation impetus · Cluster mutual growth promote power

77.1 Introduction

Cluster brand is unified name, term, marks, symbols or patterns of a same cluster aggregation space, complementary or competitive relationship with the enterprise and its branch in the same cluster. The role of the cluster brand is mainly reflected on the advertising effect, the capital concentration effect, the information transfer effect and the driving effect of related industries.

S. Zhou (✉)
School of Economics and Administration, Tianjin Open University,
Tianjin, China
e-mail: zhousptj@126.com

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77.2 Cluster Brand Identity

77.2.1 Brand Characteristic

First, the cluster brand has the general characteristics of the brand, such as property, interests, values, culture, personality and customers (Sun and Nie 2006).

1. *Attributes*

Attributes refers to the quality connotation of enterprise clusters and the impression given to evaluators that represented by enterprises cluster brand, it may represent a certain quality, function and efficiency, etc.

2. *Interests*

What evaluators caring are interests rather than enterprise cluster's attributes. In evaluators' mind, enterprise cluster brand is usually different degree of interest symbol.

3. *Value*

Enterprise cluster brand will form different hierarchy due to their represented by the enterprise, product or cluster quality and reputation, and thus form different value in evaluators' mind.

4. *Culture*

Enterprise cluster brand is the carrier of cluster peculiar culture, what can make people produce various association corresponding with its cultural background, thus to determine choices and standards.

5. *Personality*

Enterprise cluster brand also reflect a certain personality, make people think about some people or things what have distinct personality characteristics, thus making the cluster brand effective identification function.

6. *Customers*

Enterprise cluster brand is usually liked and chosen by a certain customer groups, what implying unique cluster segments market and target customers, and relevant marketing strategy.

77.2.2 Regional Characteristics

Enterprise clusters are concentrated in the same region in which the certain resources endowment are more advantages, therefore, cluster brand general has strong regional characteristics, such as geographical characteristics, and resource advantage or humanities history origin and natural style, etc. It is the integrated embodiment on enterprise brand, industry brand collective behavior in a certain regional, have the general connotation of brand (Wang 2009).

77.2.3 Public Product Characteristics

Enterprise cluster brand is owned not by one enterprise, but by many enterprises within a cluster, what will bring jointly collective benefit, is common assets of enterprise cluster, has typical public product characteristics (Xiong and Wang 2007). Cluster brand is enrichment and refine of many famous enterprises brand essence in the region, and is unified brand with more extensive and representative.

77.2.4 Brand Coordination Characteristics

The advantage of cluster brand is the coordination effect, can reduce enterprise's marketing costs, show the enterprises strength and image. But the biggest problem is easy to generate brand collective punishment effect that affect enterprise's all products image and the entire enterprise prestige for one product's problems (Shen and Guo 2008).

77.2.5 Industrial Advantages Characteristics

Cluster brand is a well-known brand common owned by enterprises in an advantage industry, and with high market share and influential in the industry market. The advantage industry is the substance foundation and value foundation of brand formation.

77.2.6 Cluster Dependence

Cluster brand formation has obvious cluster dependence; cluster is a support of cluster brand. For an enterprise cluster, resources, traditional and historical opportunity are the reasons for an industry initially at a regional district, form the enterprises initial concentration. A large number of relevant enterprises collection in a region, and gradually form the regional proprietary element accumulation and industrial structure. Thereafter, cluster gradually grows and the overall competitiveness of enterprise clusters is improved, gradually support an influential cluster brand. Visible, the formation of cluster brand has obvious cluster dependence and time dependence.

77.2.7 Brand Effect Permanence

Life cycle of single enterprise or individual product is relatively short, so the brand effect is hard to sustain. Cluster enterprise follows the competition of the survival of the fittest, cluster brand effect can be sustain if there aren't the external causes such as technology, requirement or their own conditions to cause a cluster be recession or transition (Jia 2008).

77.2.8 Dynamic

The development of enterprise clusters will experience the different period of germination, development, maturity, upgrade, recession, and so on, cluster brand will be produce when enterprise clusters develop to a certain stage. Subsequently, cluster brand will develop with enterprise clusters, and cluster brand will also experience the different stages of germination, development, maturity, upgrade, recession and so on. When the enterprise clusters go toward the downfall due to various reasons, the cluster brand also be gradually decay. Cluster brand development is dynamic and constantly changing (Yao et al. 2010).

77.2.9 Management Subject Diversity

Cluster brand is intangible assets jointly owned by multiple enterprises in cluster. Except each enterprise in cluster, its management subjects have local governments, industry associations, and other middle organization.

77.3 The Dynamic to Cluster by Cluster Brand

Once the cluster brand is formed, its influence will lead to more related with the regional enterprises to the region gathered, at the same time, a lot of money, abundant labor, advanced technology, timely market information and other factors will also continuously flock into regions, which provides a strong support to the cluster expansion and technological upgrading. Furthermore, the public properties of cluster brand need cluster enterprises to work together to create and maintain, which conducive to the cooperation among enterprises.

Therefore, the cluster brand plays roles to cluster by cluster cohesive, display power, identification strength, competitive power, innovation power and profitability and trust power.

77.3.1 Cohesion

Cluster brand is intangible assets of cluster, and have intrinsic and lasting cohesion. Cluster brand and enterprise clusters complement with each other, bring out the best in each other. Enterprise clusters produced a cluster brand, in turn, cluster brand attracted many enterprise to concentrate.

77.3.2 Display Force

Cluster brand is a display of enterprise cluster image and the products reputation. Cluster brand represents advantage of product price and product quality; also represents some good social service offered by location, consequently, it can effectively maintain enterprise customer loyalty within a cluster, plays an important role to establish customers' good relationships by cluster enterprise. Good cluster brand can ascend cluster's whole image and establish cluster brand, is equivalent to cluster established a cluster image platform for cluster enterprises.

77.3.3 Distinguishing Force

Clusters brand is the purchaser's general cognition formed a certain type of products in cluster regional, and also is a kind of product image and value dimension based on buyers' cognitive, and this brand will be branded with the obvious mark. The basic structure of the cognition is obviously cluster products' competition status, characteristics, advantages and disadvantages in the industry market competition within a cluster, is the value of product created to buyers. Once a well-known cluster brand is established, it will help buyers' to identify product; and products within a cluster can expand market depend on good brand recognition, which could obviously economize marketing costs, laid solid market demand foundation of large-scale development and expansion for cluster.

77.3.4 Competitiveness

Cluster brand is based on advantage industries in the regional, is the intangible assets jointly owned by the enterprise in the cluster. It's not only the recognition elements to distinguish the same industry between the cluster and other clusters. It is an important source to obtain market competitive advantage in enterprise clusters. If cluster has a clusters brand with wide popularity and reputation, it will become an important weapon that the enterprise within a cluster to carry on the market competition, what will has great significance to attract cluster factor resources, enlarge market share, promote the industry competitiveness.

77.3.5 Creativity

Creativity force refers to cluster brand helps to improve innovation incentive effect of industrial cluster. Innovation is the sources of sustaining competitive advantage in industrial cluster, and innovation with technical innovation as the core is a necessary conditions to upgrade the enterprise industrial. Firstly, brand is the value and commitment to provide to buyer, cluster brand needs high quality products connotation as a support, what force cluster enterprise pays attention to values technical progress and innovations. Secondly, when the market effects and competitive advantage of cluster brand has identified by cluster enterprises, cluster brand will become a common goal guide, what helps cluster enterprise to integrate elements such as technical resources, human capital innovation. Thirdly, enterprise organization innovation and institutional innovation usually be accompanied in the cluster brand strategy implementation process.

77.3.6 Profitability

For cluster enterprise is concerned, the benefits from cluster brand is generated through enterprise enjoying the intangible assets—cluster brand, and is the inner and lasting. Cluster brand has the nature of public products to enterprises in the cluster, once cluster brand formed, any enterprise in the cluster will enjoy the benefits from cluster brand.

77.3.7 Trust Force

Cluster brand promotions the formation of cluster trust mechanism. Enterprise cluster's network organization form and competitive advantage produced from the division and cooperation, long-term trade relations between enterprises. Trust is the core mechanism to forming and maintaining the long-term, stable trade relationship (Pang 2008). The long-term repeatability trading promoted the formation of enterprise clusters trust mechanism, strengthening the long-term cooperation within the cluster (Li et al. 2009).

77.4 Five Powers Analysis of the Cluster Brand

Cluster brand growth is a positive process of cluster brand value continuous improvement with the cluster growth and the cluster brand recognition and reputation constantly improve. This paper argues cluster brand growth related to the five factors, which are cluster brand learning ability; government driving force; industry association cohesion; cluster innovation impetus; cluster mutual growth promote power, analysis the five cluster brand growth forces (Fig. 77.1).

77.5 Analysis of Cluster Brand's Five Forces

77.5.1 Cluster Brand Learning Ability

1. *Formal brand learning and informal brand learning*

There are two ways to brand learning among cluster enterprises: formal brand learning and informal brand learning. Formal brand learning in the cluster is a formal cooperation relationship established on formal contract based on knowledge exchange among brand enterprises or brand enterprises and research institutions. Informal exchange of tacit knowledge transfer is an important way, through two channels in the cluster: first, the social network; second, associations or meetings (Yao et al. 2010).

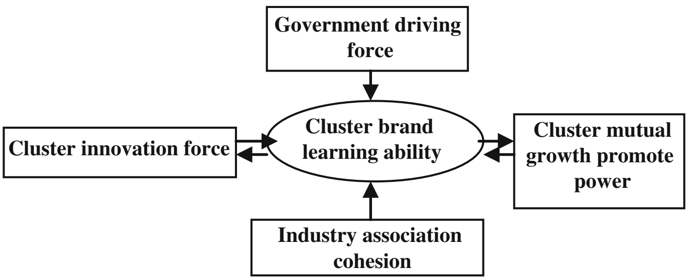

Fig. 77.1 The five forces of cluster brand growth

2. *Vertical learning ability and horizontal learning ability*

Depending on whether locate the same link in value chain; the cluster brand learning ability can be divided into vertical brand learning ability and horizontal brand learning ability. Vertical brand learning ability is products trade and services learning ability located in the different link of value chain, such as mutual participation in inter-organizational and knowledge transfer in new product development process; horizontal brand learning ability is learning ability located in the different link of value chain, including a variety of formal cooperation in brand development, research and development cooperation, mergers and acquisitions. There is an important way for disadvantaged businesses to enhance the brand is copied to the other brands, another brand of product, management, marketing can be quickly copy in cluster, thus contributing to the cluster brand growth.

77.5.2 Government Driving Force

1. *Guiding force*

In addition to the daily supervision of the cluster brand, government can serve as a leading force in building the cluster brand. As an administrative agency, government not only concerned about regional economic growth, but also the pursuit of full social and ecological benefits. Cluster brand-building mode dominated by government focuses on the formation cluster of the planning, direction and management, through scientific review advantages resources and features economy within the region, adjustment and optimization industrial structure, vigorously cultivate leading industries, to speed up the formation and upgrade of cluster, to promote the formation of influential cluster brand based on cluster.

2. *Service force*

Government service force is needed to grow cluster brand. The nature and structure of government determines its do not have the market adaptability and competitiveness which the enterprises have in direct production and commercial activities, it will distort the market mechanism that government intervention in business operations and the formation of cluster. Thus, the role of government in the cluster analysis of the brand should be repositioned as a public service government, and in order to achieve its leading role.

3. *Management power*

Government should strengthen the supervision of the cluster brand assets, through a clear definition and effective protection of property rights, to stimulate economic agents to rational use and protect brand. Strengthen the laws and introduction effective disciplinary mechanism to reduce the expected utility based on the non-cooperative game in illegal business, to combat acts of break faith.

77.5.3 Industry Association Cohesion

Industry association is the economic organizations in the same nature of economic activities, to volunteer create the non-profit voluntary organization of social groups for safeguarding the common legitimate economic interests. Industry associations play verity roles such as provider of information, business manager, coordination and service providers in the process of cluster brand growth.

1. *Information provider*

As a representative of the general membership, industry associations are specializing in the types of information collection, collation and analysis, it have information superiority can not be compared with other organizations (Ma 2008). Industry associations in the cluster have information database function. The Industry associations integrate a large number of knowledge and information, represent the overall interests of regional specific industry and have professional and collective. Meanwhile, as the industry platform for corporate communications, industry associations promote the exchange and sharing of information among its members.

2. *Operators and managers*

Industry association is set up by many enterprises together within the cluster through specific institutional, it charge fees and perform their duties for common goals of enterprises in cluster. The industry association directly cultivates and maintain cluster brand, and its more important function is to build a good platform to provide industry brand development. Industry Association promote regional products and promote regional brand through a series of planned management activities, Improve the technical and product level, to enhance the cluster brand value.

3. *Coordinator*

Industry association and other intermediary organizations have indispensable role as an intermediary in the regional marketing activities and cluster brand analysis. As a non-governmental voluntary organization formed by regional enterprises, Industry association is an important link to connect enterprise and enterprise, enterprise and market, enterprise and government. By established related industry associations in regional cluster, brand-building mode leading by it play full leadership role in building regional brand.

4. *Service providers*

Industry association is also to play its unique services function in brand establishment. Industry associations strengthen the brand's marketing efforts, focusing on market information collection, carry out market research, technical training, exchange of market information, provides business, technology, and many other advisory services; to break all kinds of market barriers and safeguard interests of the industry. Professional services institution can accelerate the enterprises growth by providing credit guarantees and market development and foster cluster brand through the provision of services for financing serves and business counseling.

77.5.4 Cluster Innovation Impetus

Cluster innovation impetus has two modes: cluster innovation network impetus and cluster innovation resources impetus.

1. *Cluster Innovation Network impetus*

Cluster innovation network is a relatively stable system on the basis of formal or informal long-term cooperation and exchange relations among the various actors (companies, universities, research institutions, financial institutions, intermediaries and local governments). Cluster innovation network is a solid foundation for the development of regional brand.

2. *Innovation Resources impetus*

Cluster is a hotbed of enterprise innovation, which can create an innovative atmosphere, provide innovative resources and maintain a lasting competitiveness of the brand. First, there has a good creative atmosphere in cluster. Frequent informal exchange accelerates the innovation diffusion, and has accumulated a large amount of "organizational knowledge" and "social capital" for enterprise innovation. Under the demonstration of the center enterprises in cluster, the passive behavior easily be turned into initiative innovation initiative sense and innovative spirit, the innovation spirit rooted in local culture permeates among industries formed the "industrial atmosphere". Second, the cluster provides good innovative resources. Cluster has the function of business incubators. With the continuous development of the cluster, a large number of enterprises in the cluster have been derived.

77.5.5 Cluster Growth Promoted Power by Each Other

It is closely related and mutual promotion between cluster development and cluster brand development. As noted above, the motive force to cluster form cluster brand has cohesive, showing strength, identification, competitiveness, innovation, profitability and confidence. The motive force to cluster brand from cluster is as fellows.

1. *Driving force*

Cluster is the driving force to format the cluster brand. The formation of cluster brand is followed with the cluster production, growing and evolving (Xiong 2007). This is because a large number of interconnected companies and institutions through cooperation and specialization form the localization network, which not only overcome the dispersion and uncertainty risk of individual enterprises participating in market transactions, and avoid the low efficiency level of enterprises. The internal mechanisms and flexibility professional production of cluster concentration, competition, cooperation, learning and innovation created the cluster marketing advantage, which led to the formation of cluster brand.

2. *Training force*

Cluster is easily birth famous-brand product and enterprise. Cluster can generate external economy and internal economy, which enable to significantly reduce enterprises operating costs, significantly improve specialization level, and create a good birth environment for "leader" enterprises. "Leader" enterprises brand will be the source of learning cluster brand.

3. *Acceleration*

Cluster is the accelerator of cluster brand communication. Cluster formation can accelerate the spread of the Cluster brand. In one area, cluster enterprises can strengthen the marketing network to achieve synergies and create a market advantage through the creation of cluster brand. After a large number of enterprises to form cluster, the intensity of advertising can be focus and form whole cluster brand by group effect.

4. *Maintenance power*

Cluster conducive to the maintenance of cluster brand. When the seller has more information than the buyer, the "lemon" market is likely to occur; the low-quality goods will expulsion the high quality goods. This would effectively safeguard the regional brand (Shanfeng and Xiuning 2005). Cluster has a unique advantage in the manufacture and dissemination of "positive market information", so it can effectively maintain the cluster brand.

77.6 Conclusion

Brand growth plays an important role in the cluster growth. This paper analyzes five forces intended to clear the of the growth elements of the cluster brand, so as to promote the growth of the cluster.

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Chapter 78
Reflections on the Team-Building of Science and Technology Innovative Talent in Shandong Characteristic Industry Town

De-liang Zhang

Abstract Team-building of science and technology innovative talent is the core to promote the development of characteristic industries in Shandong characteristic town. Based on the status quo analysis on team-building of science and technology innovative talent in Shandong characteristic industry town, this paper analyzes the problems existed in team-building of science and technology innovative talent in Shandong characteristic industry town, and puts forward with the measures to build up science and technology innovative talent team in Shandong characteristic industry town.

Keywords Characteristic industry town · Science and technology innovative talent · Shandong province · Team-building

After the State Council brought up with the guideline of "Small Town with Grand Strategy–Taking the Urbanization Road with Chinese Characteristics" in 2000, Shandong Provincial Party Committee and Provincial Government actively responded to the call of State Council and issued a series of policies and supporting measures, leading Shandong characteristic industry town to a stable development road. Till now, the characteristic industrial economy has been the major component of national economy in Shandong Province. Jun-min Wang, the Vice-governor of Shandong Province, put out (2010): "The development of characteristic industry town has important strategical significance on the mode-change, structure-adjustment and the promotion and increase of employment, and there is a large developing room." During the 11th five-year plan, the characteristic industry town in Shandong has relied on the advantageous resources to develop such characteristic

D. Zhang (✉)
Shandong Polytechnic University, School of Business, Jinan, China
e-mail: zhangdel@126.com

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industries as food, chemistry, equipment manufacturing, textile, garment and shoes (leather), electronic information and home appliance, construction material, furniture, industrial arts, hardware, plastic, automobile and its fittings, boat and marine engineering, forging, new material, new energy, and pharmacy (Shandong Economic and Information Technology Commission 2011). The small and middle enterprises in Shandong Province converged quickly at the characteristic industry town and industrial clusters, forming a batch of well-known regional brands for characteristic industries. There were totally 140 characteristic industry towns being supported with emphasis in Shandong Province. By the end of 2010, there were 71,311 small and middle enterprises gathered in all kinds of characteristic industries in Shandong Province, with 3.75 million employees, fulfilling sales revenue of RMB 1,165 billion Yuan, and taxation of RMB 84.6 billion Yuan.

The science and technology innovative talent team in characteristic industry town is the core to push the development of economy with Shandong characteristics, and plays the demonstration and leading role for the building of the entire talent team. On the development of characteristic industry, the science and technology innovative talent plays a determinate role. Along with the rapid development of Shandong economy, the demand on science and technology innovative talent in characteristic industry town will increase further, but the team-building of science and technology innovative talent in Shandong characteristic industry town is laggard, thus both the quantity and the quality of science and technology innovative talent at present can't meet the need, which restricts the rapid development of characteristic industry in Shandong. Therefore, it is the basic requirement for the sustainable development of Shandong economy to further cultivate and attract science and technology innovative talent applicable for Shandong characteristic industry town.

78.1 The Results Achieved During the Team-Building of Science and Technology Innovative Talent in Shandong Characteristic Industry Town

From the view of the developing course of Shandong characteristic industry town, the science and technology innovative talent in characteristic industry town mainly refers to talent in the following areas: the first, the science and technology innovative entrepreneur (private entrepreneur and farmer entrepreneur) (Wang and Ji 2011), including Chairman of the Board and General Manager of the enterprise; The second, the science and technology talent in characteristic industry town (Liu and Zhang 2010); The third, the academic leaders and engineers in characteristic industry town (Liu and Zhang 2010).

In recent years, surrounding the development of characteristic industrial economy, Shandong Provincial Party Committee and Provincial Government has enhanced the team-building of science and technology innovative talent in characteristic industry town from three aspects: development, use and attraction. It makes the talent's whole quality in characteristic industry town improve steadily, its structure optimize, and primarily forms science and technology innovative talent team with certain scale in characteristic industry town, leading to a new road combining the selection of local science and technology innovative talent in characteristic industry town from multichannels with the reasonable introduction of science and technology innovative talent into characteristic industry from the out side of Shandong Province. The results they achieved are as follows: firstly, construct the policy system for team-building of science and technology innovative talent in Shandong characteristic industry town, and have issued such files as "Middle- and Long-term Talent Development Program of Shandong Province (2010–2020)"; secondly, manage to solve the problem of unreasonable structure of science and technology innovative talent in characteristic industry town, enhance the talent cultivation force, and have implemented "The Cultivation Plan for Innovative Technology Leading Talent in Shandong Province", "Introducing Thousands of Overseas Innovative and Entrepreneurship Talent" plan, "The Cultivation Project for Excellent Enterprise Manager", "The Project for the Growth of Young Elites in Shandong Province", "The Promotion Plan for Entrepreneurship Talent", "The Development Plan for High-skilled Talent" (Shandong Provincial Party Committee and Provincial Government 2011); thirdly, actively expand the channels to introduce science and technology innovative talent into characteristic industry town, and achieve certain results in the work of gathering various talent. Till June 2011, there were 39 foreign experts who have won the National Friendship Award, and 27 foreign experts gained Qilu Friendship Award. 82,000 person-times of foreign experts were introduced, 11,000 person-times of people from different fields were trained, more than 870 technologies were introduced, with more than 1,260 varieties of new products. 20,000 overseas students returned to Shandong, bringing in 18 innovative entrepreneurship bases and 38 high-tech business parks; fourthly, the total amount of science and technology innovative talent in characteristic industry town is increasing year by year, and the structure of science and technology innovative talent is gradually reasonable. By the end of 2011, there were totally more than 4,000 high-level innovative talent in Shandong Province, 38 Academicians, 303 Taishan scholars, 99 at national level, 122 experts with outstanding contributions to the country, 2800 experts enjoyed State granted allowance, 600 young experts belonged to the Shangdong province, 700,000 talent with advanced skills, 380 chief technicians. There are more than 190 doctoral and postdoctoral workstations. With the number of science and technology innovative talent increasing, its age structure tends to be more reasonable and younger.

78.2 Problems Existed in the Team-Building of Science and Technology Innovative Talent in Shandong Characteristic Industry Town

78.2.1 The Science and Technology Innovative Talent in Characteristic Industry Town Distributes Unevenly, and its Flow is Out of Line

The middle- and long-term problem during the economic development in Shandong is the uneven distribution of science and technology innovative talent in different regions and industries. At present, there are more than 350 professional and technical talent per 10,000 people, the number of which ranks 13th in the country, and 797 less than that in Beijing and 132 less than that in Liaoning; there are 15 technicians per 10,000 people; and the amount of scientists and engineers per 10,000 also ranks 13th in the country (Hui 2007). This does not match with the provincial total population and economic scales in the whole country, indicating that professional technicians are still in desperate need, and are centralized in the east. In addition, two-way flow of science and technology innovative talent is out of line, with most flowing to the better developed areas, such as Jiangsu, Zhejiang and Guangdong. Most of the talent flowing out are the academic leaders and technical experts in the characteristic industry, while those who flow into Shandong are college graduates.

78.2.2 Science and Technology Innovative Talent Have Low Compensation and Bad Working Condition in Characteristic Industry Town

At present, Shandong science and technology innovative talent in characteristic industry town are commonly unsatisfied with the working and living environment. Though a series of measures have been taken to improve the compensation and working conditions, such problems cannot be fundamentally solved due to the factors of social environment and economic development, especially the problem of low compensation. Therefore, it is difficult to retain science and technology innovative talent and introduce new ones. With the economic gap between Eastern and Western parts becoming larger and larger, the gaps in compensation and working conditions are consequently becoming larger as well, which results in science and technology innovative talent to flow into the better developed areas (Wang 2007).

78.2.3 The Structure of Science and Technology Innovative Talent in Characteristic Industry Town is Too Simple and Lacks of Leading Character

In the team of science and technology innovative talent in characteristic industry town, there is large gap between the capability of entrepreneurs and the actual need; there is also large gap between the capability of academic leaders and engineers and the real demand of the working post. From the view of diploma constitution among professional technicians, the number of people with bachelor's degree is smaller, especially those with master's degree or above. From the view of professional structure, excellent talent in characteristic industry are scarce, the academic ladder is not complete, the R&D and conversion capability is low, so there is little research efforts which have important impact both in and out of the country. With the rapid development of characteristic industry, there is an increasing demand of science and technology innovative talent, especially the academic leaders and science and technology innovative entrepreneurs.

78.2.4 The Evaluation System of Science and Technology Innovative Talent in Characteristic Industry Town is Not Complete, and the Building Environment of Talent Team Needs to be Optimized

There is no good evaluation system of science and technology innovative talent in Shandong characteristic industry town. Current evaluation system is basically based on the diploma and job titles. On the determination of job titles, the rating standard always highlights the amount of papers and research expenses. In the evaluation of actual ability, it is generally based on the moral quality and the recognition by one's leaders and the fellow colleagues, which lacks scientific and specific evaluation criteria. During the fruit evaluation, it puts emphasis on short-term achievements, and ignores the long-term and systematic research in characteristic industry. On the screen of excellent science and technology innovative talent, there is lack of precise talent and performance assessment methods, which seriously affects the scientifical and systematical adminstration on science and technology innovative talent. In addition, the growth and development environment of science and technology innovative talent in characteristic industry is very bad, where exists the "official orientation consciousness".

78.2.5 The Incentive Mechanism of Science and Technology Innovative Talent in Characteristic Industry Town is Not Complete, Which Lacks of the Growing Platform for Talent

Although the level of economic development in Shandong is relatively high, it still puts emphasis on mental stimulation too much when comes to the rewards on science and technology innovative talent in characteristic industry town, which can not reflect the talent of the law of demand and the value they contributed. In fact, the material incentives always have been substituted by praise from leaders, reputation incentive and political honor. Even if there is some material incentives, it often is symbolistic, which cannot correctly reflect their real contribution and achievement. This kind of virtualized incentives can't realize the effect of long-term and integrated stimulation, leading to the low activity, less progressive passion and creation, as well as the low working spirit. At the same time, the platform which bears the growth of science and technology innovative talent of the Shandong characteristic industry is in shortage and lack of competitive high-tech groups and research institutes with strong competitiveness in the country. Moreover, the amount and scale of key laboratories and experimental base is small, thus there are few significant scientific and technological projects and high-level scientific and technological achievements; The factors above have led to such a problem that Shandong has insufficient capability to bear and absorb the science and technology innovative talent in characteristic industry town.

78.3 Measures to Strengthen the Team-Building of Science and Technology Innovative Talent in Shandong Characteristic Industry Town

78.3.1 Liberate the Thoughts, Establish the Scientific Talent Philosophy, Use New Working Idea to Build the Science and Technology Innovative Talent Team in Characteristic Industry Town

The concept of scientific development needs a scientific talent concept as backup. We should set up a people-oriented concept and an idea that everyone can be a talent. The constraining of degrees, status and professions should be broken up, while morality, knowledge, capacity and working performance should be regarded as a major criteria to measure talent, so that people can be cultivated and developed freely. Work and personality should be respected, and not to blame the imperfect; creativity and success should be respected, while failure should be allowed; choices should be respected so that everyone's values are represented under the guidance of more policies and fewer administration enforcement. Talent as the primary strategic resources should be fully developed, so that a good condition will be formed where everyone can make best use of their capacity. The awareness of reform should be stressed, and the mechanism of developing, attracting and making a good use of science and technology innovative talent in the characteristic industry town should be established. Strengthen the marketization of science and technology innovative talent and knowledge as capital, and develop and use science and technology innovative talent by market-oriented methods.

78.3.2 Complete Personnel Educational Training System, Increase Efforts to Train Science and Technology Innovative Talent in Characteristics Industry Town

First, around the advantageous resource exploitation and characteristic industry development in Shandong, the scientific research base and its achievements transformation base should be established (Zhou 2011), which guarantees enterprises and universities cooperate closely, promotes the interaction and integration between science and technology innovative talent training in characteristic industry and research cooperation, and establishes the effective mechanism of gathering talent and training talent. And using it as a link, the intelligence flow should be expanded by employing consultants, exchanging lectures, collaborative research and joint development, taking the initiative to attract and support the national research institutes in other provinces, engineering and technology research centers, key laboratories and other research institutions to establish branches in Shandong. A number of projects should be select and applied to our State to be the platform of gathering talent and attracting high-level personnel to realize the effective communication of science and technology innovative talent in characteristics industry town. Second, the academic leaders training project should be started-up and implemented. According to Shandong characteristics of economic development needs, relying on the National New Century Millions of Talents Project, an innovative science and technology leading talent development program, the "ten-thousand people plan" of introduction of overseas innovation talents, the Qilu youth growth project (Shandong Provincial Party Committee and Provincial Government 2011) and such academic leaders training project to promote the team building for science and technology innovative talent in characteristics industry town. Third, around the strategic adjustment of economic structure and dominant industry needs, the subjects and majors in colleges and universities should be adjusted to establish the higher education system adapting to the science and technology innovative talent needs in characteristics town. A complete system of high-level personnel training should be formed by further raising school standards and their competitiveness of the universities in Shandong.

Fourth, focusing on cultivating science and technology innovative entrepreneurs, relying on the well-known enterprises at home and abroad, universities and training institutions, the cultivation of science and technology innovative entrepreneurs in characteristics industry town should be strengthened. A science and technology innovative entrepreneurs pool in characteristics industry town should be established as a part of entire science and technology innovative talent development plan to improve the quality and management level of the science and technology innovative talent in characteristics industry town.

78.3.3 Innovate Talent Management System and Improve the Structure of Science and Technology Innovative Talent in Characteristic Industry Town

With the continuous development of characteristics industries in Shandong, the demand for science and technology innovative talent has increased. But the existing personnel management system has hindered the development of talent. Therefore the science and technology innovative talent management system in characteristics industry town should be reformed to establish a reasonable and orderly science and technology innovative talent management system in characteristics industry town (Zhou 2011), gradually break down the geographical, sectoral, industrial, urban and rural, identity and ownership restrictions, and streamline the flow channel of talent, in order to promote the science and technology innovative talent flow from universities and research institutions to enterprises and the grassroots. The post appointment system should be progressively introduced and the science and technology innovative talent appointment mechanism which guarantees talent promoting and demoting, getting in or out should be established. The science and technology innovative talent structure in characteristics industry town should be adjusted accordingly in the general laws of the science and technology innovative talent growth, using young talents boldly. In current disciplines, the intelligence and experience advantages of the old scientists should be taken, letting them be the good mentor and fully exploiting the potential of science and technology innovative talent.

78.3.4 Complete the Competition and Incentive Mechanisms Among the Science and Technology Innovative Talent in Characteristic Industry Town

Scientific and social talent evaluation and found system should be established based on the post duty, oriented by integrity, ability and performance (Ma and Li 2011). To improve talent evaluation criteria, we should overcome the tendency of academic credentials only and papers only, not expect talent to be perfect, evaluate talent based on their performance and contribution, and adhere to cultivate talent in practice and motivate them to do pioneering work. Therefore, we should complete the competition and incentive mechanisms among the science and technology innovative talent in characteristic industry town. Firstly, an allocating incentive mechanism should be established which takes the performance appraisal as the core, fully reflects the value of talent and encourages talent innovation. This mechanism should consider the features of science and technology innovative talent of Shandong characteristics industry town, adapt the market economic system, closely link with job performance, and encourage innovation and R&D of science and technology innovative talent in characteristics industry town. The allocation policy of that science and technology innovative talent in characteristics industry town participated by technology and scientific research should be made, which gives the stock right and share options incentive to the science and technology innovative talent who have made outstanding contributions in scientific research and commercialization, and implement tax preference policy. The policy should encourage and regulate the scientific and technologic personnel and engineer to take part-time job and get according salary. Secondly, the incentive mechanism of science and technology innovative talent in characteristics town should be improved. The allocating policy should be in operation, which guarantees that the payment of science and technology innovative talent is in accordant with their job. Thirdly, the science and technology innovative talent compensation system in characteristics town should be established, which adheres to the principle of combining the spiritual rewards with material incentives, improves the talent reward system which is oriented by government incentive and is leaded by employer and social forces.

78.3.5 *Update the Standards, Content and Manners of the Talent Evaluation, and Improve the Evaluation Mechanism of Science and Technology Innovative Talent in Characteristic Industry Town*

It is important to establish the new evaluation mechanism of science and technology innovative talent in characteristic industry town (Fei and Wang 2009). On the evaluation manners, the current evaluation approach that multi-departments jointly participate the evaluation shall be changed, and adopted a united approach that evaluated by agent or industrial association and institute. It also shall introduce the relative performance evaluation theory, which will refer to the operating level and status of similar enterprises in similar industries to compare, prefect the evaluation index system and software for the enterprise evaluation, set up the performance archive, improve the scientific attribute of assessment and evaluation, so as to ensure the fair and equality of the evaluation and usage of science and technology innovative talent. On the evaluation content, it shall focus on the real performance, and combine the preventive capability to market risk and the developing potential. It shall establish a comprehensive evaluation table, whose content involves in the scientific research projects they have undertook (national level and provincial level), patents they applied or being granted, the scientific and technical awards they gained, the economic benefit produced by the conversion and promotion of their patents, the essays and works they published, the academic conference above provincial level they organized or attended, as well as the training and review they participated (Zhang 2011).

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Chapter 79
Review on Affective Commitment of Manager

Feng-lian Li

Abstract So far, research on affective commitment is mostly concerning the employees, while specifically concerning managers is very rare. Referencing the domestic and foreign relevant research results, this paper tries to get enlightenments from some sporadic empirical research, and to summarize the factors affecting affective commitment of manager, and to improve the level of affective commitment of manager. This paper summarizes the definitions of affective commitment in domestic and foreign firstly, and then generalizes the antecedent variables of affective commitment of managers from three aspects: managers' personal factors, job factors and organizational factors. Finally, this paper studies the ways of improving the affective commitment of manager.

Keywords Affective commitment · Manager · Organizational commitment · Socialization of managers

79.1 Introduction

With the market economy gradually perfect in china, manager market started to form, and played an increasingly important role. When the enterprise managers play the professionalization and specialization advantage, how to make its loyalty conform to the need of enterprise growth and development has become a big problem of the enterprise at present. In many of the research about loyalty, organizational commitment is the most relevant and also the more researched concept. The commitment of managers is essential for the survival and effectiveness of large work organizations because the fundamental responsibility of

F. Li (✉)
Business School of Shandong Polytechnic University, Jinan, China
e-mail: fenglianli@163.com

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management is to maintain the organization in a state of health necessary to carry on its work (Buchanan 1974). In the absence of ownership as a motive for such concern, modern organizations have of necessity turned to the deliberate creation and protection of committed elites (Selznick 1957; Perrow 1972)

Mowday et al. (1982) made a great contribution on the initial research of organizational commitment; they saw it as the willingness of an employee to exert high levels of effort on behalf of the organization, a strong desire to stay with the organization, and an acceptance of its major goals and values.

Meyer and Allen argued that organizational commitment included three indispensable aspects: the first is affective commitment, which is the emotional need for organization, if an employee with strong affective commitment; he/she will always stay in the organization, because he/she wants to do so. The second is continuous commitment: associate with the cost of the members, that is, if an employee wants to leave the company, he/she must take the cost into the consideration. The third is normative commitment: members with a strong normative commitment will have a sense of responsibility to the organization, then they want to continue to work in the organization (Meyer and Allen 1997).

Scholars widely considered the affective commitment can better predict employees' behavior (Meyer and Allen 1997). Therefore, scholars of China often more concerned about the affective commitment dimension.

79.2 Definition of Affective Commitment

Meyer and Allen (1997) definite affective commitment from three perspectives as follows: (1) employees' emotion attached to the organization, and had a strong faith and acceptance to the organizational goals and values; (2) employees are willing to make the greatest efforts for the benefit of the organization; (3) employees have a strong desire to maintain their organization's membership. On the basis of Allen and Meyer's research, Dunham made further explanation on affective commitment. He defined affective commitment as the degree of the members are involved in and participate in the organization social interaction. It is the feelings of the individual to organization, is an affirmation of the psychological tendencies. It includes the target recognition, employee pride, and voluntary sacrifices and contributions on behalf of the organization, and other ingredients. Employees' performance of loyalty and hard work to the organization, mainly due to the deep feelings, rather than material interests.

Liu (1999) verified the Allen and Meyer's organizational commitment model, and he defined affective commitment as: employee' psychological attachment to the enterprise, and they commit to the enterprise because they are willing to do so. Ling wen-quan et al. (2000) defined affective commitment as: organization recognition, deep feelings; willing to make a dedication to the survival and development of the organization, do not even care about the reward; will not leave the organization in any temptation. Employees with a high degree of affective commitment have a strong affective backing to the organization, whether from emotion or behavior, they can integrated into the development of an organization.

79.3 Managers Affective Commitment Antecedents

Up to now, most numerous had been studies of the commitment of such professionals as scientists, nurses, and teachers to their employing organizations (Sheldon 1971; Lee 1971; Hrebiniak and Alutto 1973) and made a lot of meaningful results. But studies of organizational commitment of managers are also very small, and studies on affective commitment of managers specifically are even more negligible. This paper draw on relevant research results at home and abroad, trying to get inspiration from some scattered empirical study, and sum up the factors that affect managers' affective commitment, so as to improve the level of affective commitment of managers.

Williams and Anderson (1991) believed that the antecedent variables of affective commitment include: job characteristics, organizational characteristics, and individual characteristics and colleagues characteristics. The job characteristics include: the challenge, difficulty, consistency, clarity, and pressure, etc. The individual characteristics include: personal preference, age, marital, qualifications, tenure, education, gender, and household, work experience, etc. Liu (1999) thought that the main factors affecting affective commitment have five categories: individual characteristics, job characteristics, leadership and membership, roles characteristics, organizational structure characteristics (Liu 1999). Combined with the research of scholars, we can broadly classify the antecedents of affective commitment into three categories: individual factors, work and organizational factors.

79.3.1 Individual Factors of Managers

According to the research literature, although due to the difference in the object of study, research methods, demographic variables and organizational commitment may not be consistent (Mathieu and Zajac 1990), but overall, it has a great impact on organizational commitment indisputably. Meryer and Allen focuses on the affect of four categories of antecedents such as demographic variables, individual differences, work experience and opportunities/investment on organizational commitment in element analysis study. The results showed that age, tenure has a weak positive correlation with three forms of commitment. Among them, external control negatively associate with affective commitment, while task self-efficacy is positively associate with affective commitment. Sheldon (1971), Hrebiniak and

Alutto (1973), Steers (1977) found that age is positively related to affective commitment. Koch and Steers (1978), Sullivan and Sullivan (1982), Mowday et al. (1982) believes that education level was negatively correlated with affective commitment. Cui Xun found that gender, age, education, marital status, household, job, the number of departure and promotion had significant effects on affective commitment. Researchers generally believed that the demographic characteristics, including age, educational level, gender, marital status, work experience have some influence on affective commitment. Li Jing and Zhong Xiao-jing took the five factors as the background variables; they analyzed the impact of the five background variables on organizational commitment of managers through multivariate analysis of variance method. The analysis showed: the impact of gender, marital status and age on affective commitment is not significant; the situation of education and work experience have a significant impact on affective commitment. Sheldon (1971) found that affective commitment is related to the individual factors such as the years one in a organization, age and level of the status. Lee (1971), Hrebiniak and Alutto (1973) also found that organizational identification partially depends on years of service in the organization.

Buchanan II (1974) divided the manager's career into three stages: stage one is the first year, stage two is the second through fourth year, stage three is the fifth year and beyond by the empirical research on 279 managers of 3 industrial enterprises and 5 government agencies. He verified the situation of work completed in first year would seriously affect the development of organizational commitment through empirical analysis. The early work experience will influence the attitude of individual to organization by career (Vroom 1964). Most researchers agree that the first year of employment is the most important period to develop affective commitment, it is necessary to further research how the expectations and experience together affect affective commitment.

Using a role and exchange theory framework, Stevens et al. (1978) examines the commitment to their organization and to the federal service of 634 managers in 71 federal government organizations. Results indicate that certain role factors such as tenure and work overload and personal factors such as attitude toward change and job involvement are strong influences on commitment (Stevens et al. 1978).

Based on 285 questionnaires, Zhu ai-qin conducted an empirical study on the relationship between organizational commitment and job performance of middle managers of listed companies in Xinjiang. The results showed that the significant index between gender and affective commitment was 0.080, slightly greater than 0.05, although the males' affective commitment is higher than females', but the difference was not significant; the significant index between age and affective commitment is 0.007, less than 0.01, so there had a significant difference between different age on affective commitment; with the increase of work experience, affective commitment also increased, but the Sig. only is 0.111, greater than 0.05, the difference is not significant.

79.3.2 Job Factors

The job factors include work challenges, job autonomy, job skills, and role ambiguity. Study found that affective commitment is positively related to work challenges and job autonomy, employees with low affective commitment will have role ambiguity (Mathieu and Zajac 1990). Allen and Meyer (1991, Meyer and Allen 1997) found that job satisfaction and work challenges will affect affective commitment. Podsakoff et al. (2000) verified job autonomy, distributive justice, role ambiguity, role conflict, role load have strong correlation with affective commitment by using empirical methods. Hrebiniak and Alutto (1973) found that the role tension is the best predictor variable of commitment. Lee (1971) found that organizations identify partly determined by the sense of achievement, relationship with superiors. Job involvement, job satisfaction, the satisfaction to the person in charge and colleagues, career commitment were highly correlated to affective commitment (Liu 1999). Li jing and Zhong xiao-jing' empirical studies showed that job burnout and organizational commitment was a significant negative correlation, among them, deindividuation and personal accomplishment reduce had significant negative impact on affective commitment.

79.3.3 Organizational Factors

Organizational factors include organizational support, sense of fairness of organizational policy, organizational trust, organizational climate, management practices, organizational culture and relationship with colleagues and superiors. Study found that the more support from the organization staff can percept the higher affective commitment (Liu and Wang 2002). The fairness of organizational policy that members perceived is positively related to affective commitment (Konovsky and Pugh 1994). Zhang mian et al. proved that distributive justice has a significant impact on affective commitment. Geyskens et al. believed that in the distribution system, organizational trust is positively related to affective commitment. Brown found that individuals tend to identify the organization in three cases: when they think that organization will provide opportunities for personal success; when they have the power in the organization; when they haven't find a better organization. Sheldon (1971) found that commitment is related to social participation with colleagues.

The results of Buchanan II (1974) study are generally consistent with the common themes found in the review of similar research early. Collectively, these studies identified years of organizational service, social interaction with organizational peers and superiors, job achievement, and hierarchical advancement as

Table 79.1 Summary of predictions

Experience
Stage 1
Role clarity
Peer group cohesion
Group attitudes toward organization
Expectations realization
Reality shock
First-year job challenge
Loyalty conflicts
Stage 2
Personal importance
Self-image reinforcement
Fear of failure
Organizational commitment norms
Work commitment norms
Stage 3
Organizational dependability

determinants of various aspects of commitment. Buchanan II found measures of similar experiences to be significantly related to commitment. Buchanan II divided manager's career into three stages. Table 79.1 summarizes the experience predictions for each of the three stages.

Table 79.2 presents the results of a multiple regression in which the commitment scale was designated as the dependent variable and the 13 experience scales the independent variables. Only those experience scales contributing at least 0.01 to explain commitment variance (R^2) entered the equation. As shown 7 experiences entered the equation and collectively explained 68 % of the commitment variance.

Parnell and Crandall (2003) summarized job satisfaction, perceived promotional opportunities, and seniority, have been found to positively correlate with organizational commitment (DeConinck and Bachmann 1994; Bolino et al. 2001) and he verified that propensity for participative decision-making (PPDM) was significantly related to organizational commitment, and growth factors and challenging factors in job satisfaction positively while social factors in job satisfaction negatively related to organizational commitment.

Li hu et al. believed that when managers feel the direct impact on their decisions making process is fair, they are more likely to accept the results of these decisions. Studies have found that a fair decision-making process can enhance the level of commitment, and increase the sense of trust and belonging in the senior management team (Kim and Mauborgne 1993). Hu Bao-ling and WangXiao-fei empirical results found that organizational support as well as continuous commitment have a significant positive impact on affective commitment.

Table 79.2 Multiple regression depicting impact of experiences on organizational commitment

Organizational experience	Standardized coefficient
Personal importance	0.21
First-year group attitudes toward organization	0.12
Organizational dependability	0.15
Organizational commitment norms	0.12
First-year job challenge	0.19
Current group attitudes toward organization	0.23
Peer group cohesion	0.08
N = 279	
F = 85.42, $\rho = .0001$, $R^2 = .68$, df = 269	
•	
$\rho < .01$	

79.4 Research on the Way to Improve Affective Commitment of Managers

79.4.1 Managers Personal Significance Reinforcement

Managers who feel that the work they do makes real contributions to organizational success are more likely to develop commitment than those who lack this feeling (Argyris 1964; McGregor 1967 Campbell et al. 1970). First, a manager can directly verify his significance if there is an observable link between what he does and the success of his organization. Second, a person can sense how his colleagues rate him, whether they see him as a competent and valued associate.

In addition, another experience concerns the extent to which managers senses that the organization expects them to be committed (Berlew and Hall 1966). Therefore, the high level of organization should enhance communication with managers, so managers can clearly perceive the high expectations and trust.

79.4.2 Stability of Expectations of Managers

This experience concerns the consistency with which the organization meets the expectations of its managers in areas of importance to them. Such expectations include those for salary increases and promotion. But more important for managerial commitment may be the extent to which managers perceive stable commitment on the part of the organization to its own goals (Buchanan 1974). Wanous found that correlation coefficient between expectation satisfaction and organizational commitment is 0.39. Major and Kozlowsk found that unsatisfied expectation has a negative impact on organizational commitment. Therefore, to improve managers' organizational commitment, it is important to establish appropriate incentive pay system for managers.

79.4.3 Positive Work Experience of the Initial Stage

Irving and Meyer found in the initial several months of work, positive work experience will lead to higher organizational commitment. The importance of the initial work assignment for the eventual development of commitment is great (Buchanan 1974). This early experience can profoundly influence an individual's attitude toward his organization throughout his career (Vroom 1964). Therefore, in the early stages of the managers' career, the organization should try its best to create a good working environment to make employees achieve fun and success of the work, which contribute to the development of affective commitment to the organization.

79.4.4 Socialization of Managers

Buchanan II (1974) believed reference group experiences concerns the nature and intensity of a person's association with his organizational peers. Three such experiences were found to influence commitment: first-year group organizational affect, current group organizational affect, and current group cohesion. Therefore, the socialization of managers is an important way to create organizational commitment. The more characteristics held in common, the greater is the ease with which a group becomes an effective team. The factor most important for a positive organizational view among members of a group is a collective respect for and identification with its mission. For individuals, strengthen the interaction and communication with peers and superiors who hold a positive attitude towards the organization can enhance the identity to organizational goals and values, which is the most important prerequisite to acquire managers' stable commitment. Whether policies and mission of organization can be identified by managers has a great influence on the establishment of management commitment.

79.4.5 Justice and Support of Organization

It is generally considered that the employees will evaluate their work experience according to whether they be treated fairly or whether their interests be concerned by organization. If so, the perception of fairness and support will be the more direct reasons for development of organizational commitment. Several studies have investigated the influence of fairness of consequence and procedure on organizational commitment. Folger and Konovsky, for example, found that the fairness of consequence explained more variance in the wage satisfaction than procedural fairness, while procedural fairness explained more variance in organizational commitment. Sweeney and Konovsky also come to similar conclusions.

Empirical studies by Fu Wen-feng et al. showed that organizational justice and affective commitment were positively correlated, procedural justice and affective commitment is a clear causal relationship, but the causal relationship between distributive justice, interactional justice and affective commitment is not obvious. Therefore, the reasonable, open and fair procedure can make managers produce a sense of trust and higher affective commitment, and they will do their best to service the organization and will not easily leave the organization.

Eisenberger (2002) put forward norms of reciprocity and exchange theory, he believed when employees feel the organization's concern, support and recognition, and they will have a good performance. The positive correlation of organizational support and affective commitment has been proved. So, to cultivate the affective commitment of employees, the organization must first prove their commitment to employees. Empirical studies by Lynn and Sand have shown that the greater support from the organization that employees perceived, the higher the affective commitment. As an important part of the organization, managers will be more so. Therefore, if the organization can provide appropriate support and trust, managers will always loyal to the organization.

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Chapter 80
Innovations of Human Resource Management in New Knowledge Economy Times

Jing-yi Sun

Abstract With the development of advanced technology and the wide use of internet and e-business, human has entered into a new era which is knowledge economy times. One company's competitive advantages are influenced by the knowledge and technique it owns. The focus of competition goes from obtaining nature resource and real capital to achieving various knowledge and intellectual innovations. The determinant factors of competition rely largely on the effective allocation of knowledge recourse. The survival and development of an enterprise increasingly depend on the ability to form high qualified and well trained teams. This requests enterprise possessing excellent employees, with great sensibility of knowledge and technique to constantly update products and services. Therefore, the innovations of human resource management become the vital task for modern enterprise management.

Keywords Human recourse management · Innovation · Knowledge economy · Strategies

80.1 The Innovation of Human Resource Management in New Business Times

In economics, resource is defined as the universal name of all materials people put into process to create values, including human resource, material recourse, financial resource, information resource, time resource and so on, among all of these resources human resource is one of the most important one (Dessler 2010). Enterprises use Human resource management to organize and coordinate other resources to achieve strategic goals.

J. Sun (✉)
Economics and Management School, Wuhan University,
Wuhan, China

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In America, three quarters researchers are working in their company or organization's research center. On the contrary, 75 % large and medium size state enterprises in China does not have specialized researchers and rely heavily on importing foreign technologies. The process foreign experts installed all the equipment and trained workers on the product line and give them back to Chinese enterprises is called turnkey project, which has very low profit remaining, especially in labor intensive enterprise it is only about approximate 2 % (Zhang 2005). China has been endeavored to develop high technique and new industries, however there are only few attentions paid to upgrading our current human resource management strategies, to unrevealing the magnificent potentials of HRM.

80.2 Characteristics of Human Resource Management in New Knowledge Economy Times

80.2.1 Advanced Technology

From telephone meeting to television meeting to internet meeting, technology such as computer and internet is diminishing the distance of space between enterprises and people, making this world smaller and more reachable. On one hand, the fast speed of spreading information of services and products provides new space and opportunities for development. On the other hand, advanced technology also curtail the periods of upgrading products and service which in the end provoke the competitions among enterprises (Robinstein 1976).

80.2.2 Capitalization of Human Resource

In knowledge business society, the core competences are knowledge, technique and information (Stringer 2000). Human as the one who create and apply those elements is by all means the most critical resource among all others. Human capital is the knowledge, techniques, capabilities, experiences and proficiencies owed by employees. Based on the deficiency of natural resources in nowadays, human capital that has the ability to best allocate and utilize resource become more and more central to all.

80.2.3 Scientization of Management Means

HRM transforms from traditional and experienced style into more scientific and specialized manner with the entrance of knowledge economy era. The e human resource (EHR) management system brings a brand new experience of scientific management. Through positive application of EHR, a bridge between staff and human resource department can be built by utilizing proper systems, such as staff self-serving system, payroll calculating system, training system, performance management systems and so forth (Mils 1965).

80.2.4 Constant Training

The attention paid to training employees has grown rapidly for the sake of long term prosperity (Dowling et al. 1994). No matter the importance of knowledge itself or the fast speed of knowledge upgrading, employees face great pressure to generate new knowledge and techniques. Enterprises must constantly strengthen the training of their staff to adapt prompt changes and growing societies. Thus, training and learning is a lifetime need to employees. Emerging industries definitely need to keep that in mind in practice.

80.3 Importance of Human Resource Management Innovation

80.3.1 Innovations Urge Enterprise to Reform

To develop socialized production and market economy must improve the modern enterprise system that can allocate its resource effectively and run its business plan smoothly (Schuler and Florkowski 1996). These require reinforcing and developing human capital which is the most important factor and also the prosecutor of all operations.

80.3.2 Innovations Improve Enterprises' Core Competences

In order to win from the complicated international business environment, enterprises need to continuously participate in the global completion and cooperation to learn and upgrade their knowledge. Promoting innovation of HRM can give full play to enterprises' advantages. Mastering and learning more advanced technologies is vital to the designs and the researches of future products and services, which as well ensure larger market share seized and wider customer base attained.

80.3.3 Innovations Form Well Qualified Team

The management level of an enterprise affects its development directly therefore is the key to decide whether the company performs good or not (Howard and Ferris

1996). The quality of HRM in a certain degree determines the way leading to success or failure. At the present stage, the development of market economy asks for high qualified teams to make high qualified enterprises. Only enterprise improving the innovation of HRM can fully support selection mechanism, incentive mechanism and supervision mechanism to build a suitable developing environment for employees who perform better in better working mechanism (Mytelka and Smith 2002).

80.4 HRM Innovation Strategies in New Economic Business Environment

Under the guide of information technology revolution, the most critical resource is not material source but know-how that deciding the spirits of innovation and competing leverage (Senge 1990). Who owns higher level of know-how, who wins. In new economic times, HRM must keep space closely with the innovation in the following areas to realize the mutual goals of staff and enterprise.

80.4.1 Personalize HMR Means

With the coming of new business times arises the changing of outer environment (Sherman 1993). Every individual has his or her unique specialties by different culture backgrounds, experiences and principles. The attentions enterprises pay to different areas determines the selection criteria of hiring. Enterprise should explore the talents of its employees and assign different tasks to their corresponding specialties. Sufficient communication between staff and company is valuable to help company finds out what their employees need and what they can do. The performance assessments can apply flexibly to provoke the loyalty and potential abilities of employees, which in return generate more intangible assets. Allow every employee has a platform to reveal their talents and make them realize every individual to the company is as important as a crucial component of a machine that can only activate when every single part is in the right place.

80.4.2 Develop Management Methods

Classify different functions of HR department such as allocation, training, wages, welfares and so on (Tichy 1993). Have the unimportant, trivial and low-knowledge relating work cut off from HR department and hire professional human resource company of the third party to deal with them. Use management consulting company to reduce long term administrative cost to get enterprise free from non-important data analysis and to obtain new managerial technique and thought to adapt continuously changing environment (Guest 1989). These methods not only cut down the cost of daily operation load but also simplify the process and route from higher level management to lower. Communication is more sufficient and operational function is clearer.

80.4.3 Modify Organizational Structures

Typically, redesign the structures of an organization means power redistribution. There are four types structures, which are linier function structure, department structure, matrix structure and net structure (Quanwen 2001). There are some suggestions aiming at modifying organizational structures. First, Change the traditional pyramid hierarchical structure and decrease middle managerial levels to create shortest information flow. Second, Authorize sufficient power and function to staff so they can directly handle problems within corresponding duties. Third, allow staffs to face custom and to resume the responsibilities of the services they provide, supervisors should support, encourage and provoke staffs' potential intelligence and provide a promising stage for their performances, which brings the true value and efficacy of HRM (Huber 1990).

80.4.4 Improve Incentive Mechanism

There are two types of incentive mechanism; one is from outside and the other is from inside. The first one includes salary incentive, especially capitalization incentive such as stock option incentives that join the long term profit of the company and its staff together. The latter one, inside incentive, is a contrary concept comparing to the outside incentives. It creates certain conditions that make working fun and enjoyable. For example, delegating certain decision making power to staff to make them attain more sense of achievement, which brings more concentration of energy and excitement that boost working quality. In addition, grant more flexibility that allows staff has more space for creativities, of course under the condition that all works can be accomplished in required time and quality (Schuler 1995). Flexible working time and working place are excellent options to support such incentives. Last but not least, accept suggestion system that the voice of staff can be heard by higher management. Democracy has become gradually more important to a company's future prosperity for it enhance employees' sense of responsibility and participation.

80.4.5 Promote Corporate Culture

Corporate culture is the sum of corporate value, corporate institution and conduct norm that generated through long term survival and development. It is the soul of a corporate and has three levels that indicate its maturity. The first level is material culture; the second is institution culture and the third spirit culture (Coriat and Weinstein 2002). Corporate culture is an intangible asset to its company because it gives guidance, motivations, cohesions and constraints to the working environment. There will be no vitality if a company is lack of enterprise culture and consequently it will be disappeared from the competition battle. A people oriented company encourages its staff to view their company as families and their work as a lifetime goal, which enhances the corporation and cohesion. Great atmosphere helps staff to positively support and adapt reformation. Establishing people oriented culture and making people the most valuable assets allow full play to people's subjective initiative, linking people and enterprise become one subject that shares mutual interests and benefits. Thus the loyalty of staff will be reinforced, avoiding brain drain situation to happen. Considering the time and money a company has invested, the best way to retain a company steady and fast growing space is to keep its most precious asset, which is human resource.

80.5 Conclusion

The innovation of HRM in new knowledge economic times should not only deal with concrete issues but also well aware various problems that enterprises will face in short and long term. As practical situation differs among industries, the actual standards of developing HRM will be different according to their specific demands. One thing should take into account is that human resource as the most valuable and critical resource is the major force to seize opportunities in drastic market competitions. Well accomplished innovations of HRM can practically improve enterprise's core competences and economic benefits, pushing it become bigger and stronger.

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Chapter 81
Who is the Best Connected Researcher? An Analysis of Co-Authorship Networks of Knowledge Management from 2000 to 2010

Mei-yun Zuo, Xiao-qing Hua and Xiao-wei Wen

Abstract Who is the best connected researcher? This study uses social network analysis to address this question. Specifically, 1831 papers published in six top knowledge management research journals from 2000 to 2010 are analyzed. Firstly, by analyzing the degree distribution of the network, we find there exist a few researchers who have quite a large cooperation network, and in contrast a large sum of common researchers who have just a few cooperators. Next, we respectively identify 20 authors who have the most connections with others according to degree centrality, who are in the core positions according to closeness centrality and who play the "bridge" roles in the network according to betweenness centrality. Finally, the biggest connected sub-graphs, the 57-Actors Graph is extracted and discussed.

Keywords Knowledge management · Co-authorship network · Social network analysis · Individual status · Academic groups

81.1 Introduction

Prior research demonstrates that there are many successful and prolific individuals producing novel, interesting, and high-quality knowledge management (KM) works in refereed journals (Ma and Yu 2010; Serenko and Bontis 2009; Serenko et al. 2010;

M. Zuo (✉) · X. Hua · X. Wen
Department of Economic Information Management,
School of Information, Renmin University of China, Beijing, China
e-mail: zuomy@ruc.edu.cn

X. Hua
e-mail: vivian.hua@ruc.edu.cn

X. Wen
e-mail: elowise0516@ruc.edu.cn

E. Qi et al. (eds.), *The 19th International Conference on Industrial Engineering and Engineering Management*, DOI: 10.1007/978-3-642-38427-1_81,

Serenko et al. 2011) or conference proceedings. With contributions of these productive individuals, the field of KM developed a strong foundation from which it has now flourished. Then we may wonder about who is the best connected researcher in the field of KM? Who are the most connected researchers in the field of KM?

81.2 Literature Review

Recently, a number of researchers have realized the importance and necessities to understand the identity of KM's research community and concentrate their focuses on it. Serenko and Bontis identified a number of very productive individuals and institution on KM/IC (intellectual capital) (Serenko and Bontis 2004), developed a global ranking of KM/IC academic journals (Serenko and Bontis 2009), and investigated the presence of the superstar effect in the KM/IC academic discipline (Serenko et al. 2011). Although the scientific collaboration is also a prominent indicator of KM's research community, few papers on scientific collaboration in KM had been published.

Lately with the development of social network analysis methods, almost every aspect of scientific collaboration can be reliably tracked by analyzing co-authorship networks. Nowadays, many co-authorship networks have been analyzed in other fields, such as library science (Liu et al. 2005), information retrieval (Ding 2011), e-markets (Kai et al. 2011), medical (Morel et al. 2009) and so on, but few have studied co-authorship networks in KM discipline. In this study, based on analysis of KM's co-authorship network's structure, our objective is to identify various types of connected researchers and investigate collaboration patterns in different research groups extracted from the network.

81.3 Methodology

Social network analysis (SNA) is based on the premise that the relationships among social actors can be described by a graph. The graph's nodes represent social actors and the graph's edges connect pairs of nodes and thus represent social interactions.

Given that we have established a social network graph, we can describe its properties on two levels, namely by global graph metrics and individual actor properties. Global graph metrics seek to describe the characteristic of a social network as a whole, for example the degree distribution, graph's average path length (APL), clustering coefficient, the number of connected sub-graphs, etc. Actor properties relate to the analysis of the individual properties of network actors, e.g. actor status in a cluster. The status of an actor is usually expressed in terms of its centrality, i.e. a measure of how central the actor is to the network graph. In this article, we will combine the use of two SNS software tools Ucinet and Pajek to perform the analysis of co-authorship network.

Table 81.1 Overview of the data source from 2000 to 2010 in proquest database

Journal	Num. of papers	Available period
Journal of Knowledge Management (JKM)	586	2000–2010
Journal of Intellectual Capital (JIC)	375	2000–2010
Knowledge Management Research & Practice (KMRP)	240	2003–2010
International Journal of Knowledge Management (IJKM)	65	2007–2009
The Learning Organization (TLO)	271	2000–2010
Knowledge and Process Management (KPM)	294	2000–2010
Total	1831	

81.4 Data Collection and Pre-process

Serenko and Bontis (2009) have developed a global ranking of 20 knowledge management and intellectual capital academic journals through a survey of 233 active researchers in this field. Their goal was to select only academic KM/IC journals focusing on managerial issues, therefore pure technology-centered journals or trade journals were excluded (Serenko and Bontis 2009). Since no discrepancies of rank-order were found in the list of top 6 journals while these two scholars applied different rank-order and factor scoring methods to produce the results, we selected the Top 6 journals ranked by Serenko and Bontis as data source of this paper. We collected all the available academic papers published in these top 6 journals from 2000 to 2010 in Proquest Database, as listed in Table 81.1. Editorials, book reviews, and interviews were excluded from the analysis. In total, 1,831 papers with 2,471 authors were gathered.

The co-authorship network documents scientific collaboration through published articles, where nodes are researchers and a link represents the fact that two researchers have written at least one paper together. In this article, we build a traditional undirected, binary co-authorship network without considering the weight of edges, mainly to simplify the analysis procedures. Only in the connected sub-graphs, weight of edges is taken into consideration. Finally, we build a co-authorship network with 2,471 nodes and 2,665 edges.

81.5 Metrics for the Co-authorship Network

81.5.1 Degree Distribution Analysis

Node degree is the number of ties linked to other nodes in the network. Network density is the proportion of ties in a network relative to the total number possible (Scott 2005).

Network density calculated by Ucinet, only 0.0006, indicates that co-authorship network is quite a sparse network. The average node degree is 2.52, namely one researcher cooperate with 2.52 researchers on average. Specifically, the best connected researcher, Bontis has a degree of 38, and the least connected researcher's degree is 0, which suggests that he/she didn't cooperate with anyone. In total, there are 356 researchers who prefer to work alone, accounting for 14.40 % of the 2,471 researchers.

A quantity that has been much studied lately for various networks is the degree distribution, P(k), giving the probability that a randomly selected node has k links. Networks for which P(k) has a power-law tail, are known as scale-free networks. The degree distributions of co-authorship network indicate that it is scale-free. The power-law tail is evident from the logarithmically binned data, which suggests that a few researchers have quite a large cooperation network, and in contrast a large sum of common researchers just have a few cooperators. The regression equation is $\log(f) = -2.694 \log(N + 1) + 3.629$, R Square = 0.8712 (f is the number of nodes that has N links).

81.5.2 APL and Clustering Coefficient Analysis

Path length is the distance of shortest path between a pair of nodes in the network, and average path-length (APL) is the average of these path lengths among all pairs of nodes. Clustering coefficient ranges between 0 and 1, and a higher clustering coefficient indicates a greater 'cliquishness' (Scott 2005).

For all the pairs of nodes that can be reached from each other, the APL is only 2.37. Clearly the co-authorship network is not a connected graph, however, there may exist several connected sub-graphs.

Clustering coefficient of co-authorship network is 0.882, indicating a highly short range clustering. Specifically, there are 1,122 nodes whose clustering coefficient are 1, accounting for 45.40 % of the whole network, and all these nodes have a relatively low degree, ranging from 2 to 5. It means these researchers usually have a small cooperation network, namely 2–5 cooperators.

81.5.3 Centrality Analysis

At the individual level, one dimension of status in the network can be captured through centrality. Central researchers are well connected to other researchers and metrics of centrality will therefore attempt to measure a researcher's degree (degree centrality), average distance to all other researchers (closeness centrality), or the degree to which geodesic paths between any pair of researchers passes through the researcher (betweenness centrality). So the most connected researchers can be identified by these three kinds of centrality from different aspects.

Table 81.2 Three kinds of the 20 most central researchers and the 20 most productivity researchers

No	Degree centrality	Closeness centrality	Betweenness centrality	Productivity (Serenko et al. 2011)
1	*Bontis, N.*	*Bontis, N.*	*Bontis, N.*	Bhatt, Ganesh D.
2	Bukh, Per N.	*O'Donnell, D.*	Andreou, Andreas N.	Bontis, N.
3	Guthrie, J.	Henriksen, Lars B.	*Voelpel, Sven C.*	Shariq, Syed Z.
4	Metaxiotis, K.	Andreou, Andreas N.	Stankosky, M.	Joia, Luiz A.
5	Mouritsen, J.	Kennedy, T.	Guthrie, J.	Pablos, Patricia O.
6	Ergazakis, K.	O'Regan, P.	*O'Donnell, D.*	Rowley, J.
7	Serenko, A.	Cleary, P.	Bukh, Per N.	Wiig, Karl M.
8	*O'Donnell, D.*	Hannigan, A.	Henriksen, Lars B.	McAdam, R.
9	Lytras, Miltiadis D.	Tracey, M.	Davenport, Thomas H.	Liebowitz, J.
10	Mentzas, G.	Seleim, A.	Ribiere, Vincent M.	Blosch, M.
11	Johansen, M. R.	Serenko, A.	Johanson, U.	Korac-Kakabadse, A.
12	Psarras, J.	Bart, Christopher K.	Edwards, John S.	Korac-Kakabadse, N.
13	Stankosky, M.	Hardie, T.	Kianto, A.	Newman, V.
14	Klein, Jonathan H.	Booker, Lorne D.	Lönnqvist, A.	Skok, W.
15	Johanson, U.	Sadeddin, K.	Carlucci, D.	Caddy. I.
16	*Voelpel, Sven C.*	*Voelpel, Sven C.*	Sánchez, M. P.	Carrillo, J.
17	Choi, Chong J.	Grant, J.	Seleim, A.	Guthrie, J.
18	Farrell, J.	Keow, William Chua C.	Prusak, L.	Allee, A.
19	Gwyn, B.	Richardson, S.	Schiuma, G.	Beijerse, R.
20	McDonald, J. R.	Stovel, M.	Bart, Christopher K.	Beveren, John V.

1. *The 20 Most Central Researchers*: The three kinds of 20 most central researchers are listed in Table 81.2. We highlight those authors (i.e. Bontis, N.; O'Donnell, D. and Voelpel, Sven C.) with italic style ranked in all three kinds of Top 20 most central researchers; obviously, they are the most connected researchers.
2. *The Comparison between Productivity Ranking and Centrality Ranking*: Serenko and Bontis (2004) conduct a meta-review analysis of the knowledge management and intellectual capital literatures by investigating research productivity. In this article, the top 20 productively researchers are put in the right column of Table 81.2.

As shown in Table 81.2, except for two researchers (i.e. Bontis, N. and Guthrie, J.) highlighted with bold style in Top 20 productivity which are also listed in Top 20 of centrality ranking, there is an obvious difference between productivity ranking and centrality ranking. On one hand, these big changes are caused by the different periods of data source. Serenko and Bontis (2004) collected papers in Top 3 journals before 2003, while in this article papers ranging from 2000 to 2010 in Top 6 journals are included. Some of these researchers have published a large sum of papers before 2000 since they began their research in KM area as early as 1980s. However, these works are not contained in our article. On the other hand, these highly productive researchers maybe prefer to work alone. Like Rowley, J., ranked 6 in Top 20 productivity, she has only one cooperator in the network, namely her degree is only 1. Hence, she is not in Top 20 of centrality ranking.

From these researchers we learn that some highly productive researchers prefer to work alone rather than collaboration, which helps to maintain their original. This is also because they are able to publish papers on these top journals independently. In comparison, team work or collaboration is a better choice for some common researchers if their goal is the top journals.

81.6 Connected Sub-Graphs

The co-authorship network is not all connected, which includes many small connected sub-graphs. These sub-graphs, to some degree, are on behalf of different kinds of academic groups. We use Pajek to divide the network into connected sub-graphs. It is not hard to find that, most sub-graphs have 2-5 actors, there are 6 sub-graphs have more than 15 actors and only 2 sub-graphs whose numbers of actors are more than 30 (with 39 and 57 actors respectively). Next, we only analyze the biggest connected sub-graph for the limitation of pages.

The biggest connected sub-graph that extracted by Ucinet have 57 actors, including 47 articles, so we name it 57-Actors Graph.

81.6.1 Analysis of Collaboration Characteristics

1. *Collaboration Frequency*: The collaboration times between the two co-authors include 1, 2, 4, 9 in 57-Actors Graph. Most cooperation in this academic group is in a low frequency (1–2 times), but meanwhile there is a little of high frequent cooperation, for instance, there are 4 times cooperation between Bontis, N. and Bart, Christopher K.; between Stankosky, M. and Mohamed, Mirghani S.; and 9 times between Bontis, N. and Serenko, A.
2. *Geographic Distribution*: The paper collects the nationality/district information of all the researchers in the 57-Actors Graph. Most of them are American (16) researchers, next are Canada (12), then Ireland (7), Germany (4), Egypt (2), Malaysia (2), Netherlands (2), Switzerland (2), and other countries/districts, each of which has one researcher.

To understand the relationship between researchers' cooperation and nationality distribution, we build a nationality distribution network which is similar to the co-authorship network. The only difference between the two networks is that the edge in the nationality distribution network represents that the two actors are in the same nationality, while the edge in the co-authorship network indicates that they have a collaboration relationship. Then we use QAP (quadratic assignment procedures) method to exam the correlations between the two networks. QAP method is mainly used to analyze the correlations between different networks.

The result shows that the correlation coefficient calculated by simple matching algorithm is 0.871, which means that if the value of a unit in the nationality network is 1, then there will be a possibility of 87.1 % that the value of the corresponding unit in the co-authorship network is 1. In other words, there is a possibility of 87.1 % that two co-authors in the certain co-authorship network are from the same country. As the significance value is 0.000 (<0.001), which indicates that the significance level is very high (Scott 2005), the hypothesis that the two networks are highly correlated is established. This shows that researchers who co-publish an article are more likely to come from the same country.

3. *Journals for Publication*: These 47 articles are not distributed evenly in the 6 journals. About 74.5 % of the articles are published on the JKM and JIC. The paper identifies 13 core researchers from the 57-Actors Graph whose published papers cover the whole 47 articles, including 6 core super researchers whose degree numbers are more than 5, they are by descending order: Bontis, N. (38), O'Donnell, D. (15), Stankosky, M. (12), Voelpel, Sven C. (11), and Ribière, Vincent M. (9), Davenport, Thomas H. (6).

81.6.2 Analysis of Divided Groups

To better analyze the research difference of different academic groups in the 57-Actors Graph, we divide the graph into 3 small groups according to the tightness of cooperation. According to the division result, we call them Group 1, Group 2 and Group 3 successively. The features of edges (articles) and actors (researchers) in the groups are shown in Table 81.3.

From Table 81.3 we can find that the three groups have their own preferences, there is much difference among their journals where their articles are published and among their nationalities. The co-work articles of Group 1 are mostly published on the JKM, while those from Group 2 focus on the JIC, and Group 3 are also tend to publish their articles on the JIC with a 50 % of the total respectively.

It is also easy to discover that, most researchers in Group 1 come from USA, and there is respectively one researcher from the country of Norway, UK, Republic of Korea, Slovenia and Thailand, which, indicates that this group has a wide range of cooperation, distributed in America, Europe and Asia. A majority of researchers in Group 2 are with the nationalities of Canada and Ireland (As there is not too much difference between Group 2 and Bontis's Ego Network, detail analysis may be referred to below, analysis of Bontis's ego network in next Part), similarly, the group also has a wide range of cooperation, including Europe, America, Asia and Oceania, etc. However, there is no intensive trend about researchers' nationality of Group 3, where 1/3 are from Germany, 1/4 are from USA, and others are from some countries in Europe and Africa.

Table 81.3 Three kinds of the 20 most central researchers and the 20 most productivity researchers

Group	Articles			Authors		
	Journal	Num	Proportion (%)	Country/district	Num	Proportion (%)
Group 1 (14 articles; 17 authors)	JKM	8	57.1	USA	12	70.6
	JIC	3	21.4	Norway	1	5.9
	IJKM	2	14.3	UK	1	5.9
	KMRP	1	7.1	Republic of Korea	1	5.9
				Slovenia	1	5.9
				Thailand	1	5.9
Group 2 (28 articles; 28 authors)	JIC	18	64.3	Canada	12	42.9
	KPM	4	14.3	Ireland	7	25.0
	JKM	4	14.3	Egypt	2	7.1
	IJKM	1	3.6	Malaysia	2	7.1
	TLO	1	3.6	Others	5	17.9
Group 3 (11 articles; 12 authors)	JIC	6	54.5	Germany	4	33.3
	JKM	3	27.2	USA	3	25.0
	KPM	1	9.1	Netherlands	2	16.7
	KMRP	1	9.1	Switzerland	2	16.7
				South Africa	1	8.3

81.6.3 Analysis of Bontis's Ego Network

Nick Bontis is a Canadian academic and the actor with the maximum degrees in the co-authorship network, which means if we only select one scholar as the best connected researcher, he is the only one in KM field undoubtly. He is a Canadian academic at the DeGroote School of Business, McMaster University in Hamilton. He specializes in intellectual capital, knowledge management and organizational learning. We extract Bontis's ego network to analyze its research focus and evolving trends of the academic group which centers on him.

1. *Members of the Bontis-centered Academic Group*: Bontis has 23 co-authorships in total, among which 9 are from the same country as him, or even the same university, McMaster University. Except from those Canadian co-authors, Bontis also has much international collaboration. What is worth noticing is that he has as many as 6 co-researchers from Ireland. Besides, he has built some cooperation relationships with researchers that come from USA, Denmark, India, Malaysia and Taiwan. Among those relationships, Serenko, A. has the most frequent collaboration with Bontis; they together have published 9 papers. Next is Bart, Christopher K., who has a number of 5 co-written articles with Bontis. Obviously, their cooperation relations are very stable.
2. *Research Focus of the Bontis-centered Academic Group*: The Bontis-centered academic group consists of Bontis and his co-authors. He cooperated with two Malaysian researchers in 2000 and one Canadian in 2001. As the best connected researcher in the field of KM, Bontis has gained much multinational

cooperation experience. Before 2006, his co-authors each year were mostly from the same country. However, he began to cooperate with multiple nations after 2006, with co-authors in many different countries and districts, including Ireland, Taiwan, USA, Austria, Egypt, etc. In general, many of his cooperation types are transnational ones, and as the time passed by, evolve from one country to multiple countries.

According to the introduction on Bontis's homepage (www.bontis.com), he always uses method of case study. He is good at studying Knowledge Assets such as management strategy of human capital, and concentrates on knowledge assets' influence on organizations. By counting the time and keywords of their co-published papers, analyzing the content change during the session, it is not difficult to find that the group's research topic always focuses on knowledge management and intellectual capital. From studying some core problems like customer capital and human capital in the enterprises in the early time (2000), step by step, he transferred his research direction to informationization in 2001; Moreover, he turned to study some extension problems such as the relation between employment relationship, leader capability, corporate governance, knowledge management and intellectual capital in the organizations in 2002-2007; Recently in 2009, he began to pay attention to some expanding problems, for example, the application of knowledge management in teaching; Besides, according to Bontis's articles that published in 2010, we could find that as the technology grows, he put more emphasis on combining knowledge management with digital products, mobile economy, and doing some research on technology acceptance and perceived value.

81.7 Conclusion and Future Works

Based on 1,831 articles published on the 6 top journals in the knowledge management field from 2000 to 2010, this study builds a co-authorship network which has 2,471 actors and 2,665 edges according to the collaboration relationship among the researchers. By analyzing three kinds of network centrality, we respectively identify 20 authors who have the most connections with others according to degree centrality, who are in the core position according to closeness centrality and who play the "bridge" roles in the network according to betweenness centrality, those three authors (i.e. Bontis, N.; O'Donnell, D. and Voelpel, Sven C.) ranked in all three kinds of Top 20 most central researchers obviously are the most connected researchers. From the co-authorship network, it is easy to find Nick Bontis is the actor with the maximum degrees, which means if only one scholar should be selected as the best connected researcher, he is this only one in KM field. Besides, we extract the biggest connected sub-graphs from the network, that is, the 57-Actors Graph, and analyze in detail by studying its cooperation frequency, geographic distribution and journals distribution.

Based on the findings, several important implications emerged that warrant discussion. Firstly, there exist a few researchers who have quite a large cooperation network, and in contrast a large sum of common researchers who just have a few cooperators. Then academic researchers usually have a small cooperation network, namely 2–5 cooperators, and there are few connections with researchers outside their cooperation network. However, data shows that some highly productive researchers prefer to work alone rather than collaboration, which helps to maintain their original. This is also because they are able to publish papers on these top journals independently. In comparison, team work or collaboration is a better choice for some common researchers if their goal is the top journals.

Still, there are some limitations in our study. Though we have calculated the frequency of the collaboration in the biggest connected sub-graph, we should consider the co-authors sort in the same paper. Moreover, only Top 6 journals are selected in this article at present, which made the sample of papers still small for social network analysis. In the future, more high quality journals should be selected into the data source and made some analysis after considering the co-authors sort and adding the weight information of the whole network.

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Chapter 82
Study on the Standardization of Knowledge Management Facing the Open Innovation

Yang Ping

Abstract Knowledge management is becoming a key factor in determining its success or failure as the most important resource of innovative activities. But it is a problem that how to establish a close contact between open innovation and knowledge management to improve the efficiency of knowledge management and to promote open innovation. This paper systematically analyzes the standardization operation mode of knowledge input, extraction, curing, accumulation, transfer and diffusion in open innovation with the help of cloud models and multi-attribute decision theory. And get the conclusion that: the standardization work optimize the structure of knowledge management, reduce innovation risk, promote open innovation through effective flow of knowledge in the whole process of innovation by standard as a transfer carrier; standards is not only the most effective connecting link between open innovation and knowledge management, but also the multiplier to promote the common development of both.

Keywords Open innovation · Standardization · Knowledge management · Cloud model · Multiple attribute decision making

82.1 Introduction

Since 2003, the concept of open innovation raised by Professor Chesbrough (2003) had become a mainstream to improve research efficiency and reduce research costs (Shijing 2006), it could fundamentally change the innovation model, help cultivate

Y. Ping (✉)
Institute of Standard and Specification Research, Naval Academy of Armament, Shanghai, China
e-mail: ocean.py@163.com

Y. Ping
Institute of Finance and Economics Research, Shanghai University of Finance and Economics, Shanghai, China

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a deeper ability to innovate, and enhance core competitiveness, achieve cost-effective model of economic growth changes and have great significance to maintaining economic growth (Qiuping and Shengz 2011). In United States and Europe the studies and discussions on open innovation model are more and more in depth, and open innovation has been gradually integrated into the national innovation policy. Knowledge is the most important resources of open innovation activities, its production, creation and application is an evolution of complex process which run through the whole process of innovation (Jiani and Weili 2008), and is always accompanied by the development, test, mature and diffusion of the technology, so knowledge has been become a key factor in determining its success or failure. In the practice of open innovation, knowledge management has become a new model to replace the traditional product innovation management (Zhengyu et al. 2008). The standard is not only the input of open innovation, but also the output; not only the extraction and accumulation of knowledge, but also the optimization and reorganization; not only a means of knowledge management, but also the knowledge management support. With the help of cloud models and multi-attribute decision theory, this paper systematically analyzes the standardization operation mode of knowledge input, extraction, curing, accumulation, transfer and diffusion in the open innovation.

82.2 Extraction and Accumulation of Innovation Knowledge by Standardization

82.2.1 Theoretical Analysis

Open innovation is an innovative model which could rewrite the map of innovation activities, break through the organizational boundaries, use complementary and knowledge resources outside the organization to have multi-angle dynamic cooperation with a variety of partners in various stages in the innovation chain.

Compared with traditional high-cost "closed innovation" model, open innovation is an "innovation paradigm shift" which could get higher innovation output by less scientific research, is an inevitable choice to solve the lack of internal resources under the situation of scientific and technological innovation in constant acceleration. It has no fundamental changes in the internal ductility of innovation, but form a breakthrough in stretched chains and innovative ways, Yang Wu believes that it could make the organization's innovative resources recombined quantity and quality in time and space, to achieve seamless integration and overall optimization (Yong et al. 2011). The essence of this innovative system is the alliance between the internal and external knowledge base (Jihong 2011), in this process of innovation, knowledge is sustained absorbed, created, and accumulated, and continued to be reassembled (David and Foray 1995). The range of knowledge sources is expanding and the number of knowledge generated is increasing.

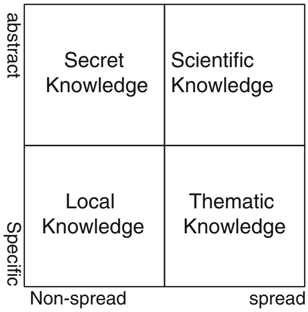


Fig. 82.1 Knowledge Type 1 (*Data from* Boesot (1995, pp 169)

Typically, the classification of tacit knowledge and explicit knowledge is the most important classification structure in the field of knowledge management (Argote et al. 2003). It is mainly based on the degree that knowledge can be presented to the division. In fact, tacit knowledge and explicit knowledge are interrelated and transformed into each other, while the standard is the most effective way of refining and sharing of tacit knowledge. Explicit knowledge is transformed from the tacit knowledge, but it also becomes the premise of the new tacit knowledge bourgeoning. Tacit knowledge deep in the innovation individual is of great value, but is difficult to exchange by market; second a lot of explicit knowledge of the various innovation units cannot fully share, resulting that this part of the knowledge may have a trend to be hidden, so that tacit knowledge content would be further increasing in the entire open innovation process. Standardization can promote the conversion from tacit knowledge to explicit knowledge. From the view of knowledge management point, these standards make individual tacit knowledge explicit essentially in the process of innovation, store it in the knowledge base, but also to ensure this knowledge does not disappear in the transfer between innovative individuals, in order to achieve knowledge share.

However, this classification with tacit knowledge and explicit knowledge is not entirely reasonable and sufficient for all the knowledge, which have been divided into eight by economists Boesot (1995) with two dimensions such as knowledge diffusion and coding, concrete and abstract (see Figs. 82.1 and 82.2). We note that the property of such knowledge is complex, may be overlap, and has a great uncertainty. In this case, the role of standards is not only to extract new generated knowledge, or convert tacit knowledge into explicit knowledge, but also screen on all kinds of knowledge according to needs of the various stages in open innovation, and classify knowledge according to the different objects.

82.2.2 Model Analysis

Uncertainty is one of the basic properties of the objective world. The generalized uncertainty includes five aspects as ambiguity, randomness, incompleteness,

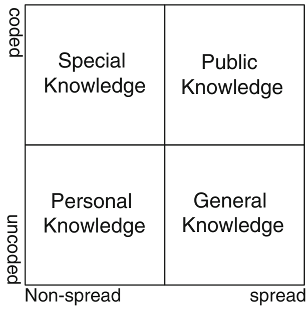


Fig. 82.2 Knowledge Type 2 (*Data from* Boesot (1995, pp 204)

inconsistency and instability. In which fuzziness and randomness are essential (De-Yi et al. 2004). This is precisely the basic characteristics of knowledge application, generation and accumulation in open innovation process. The cloud model is the conversion model between qualitative concept and its quantitative expression, formed by the specific structure algorithm on the basis of the interaction between probability theory and fuzzy mathematical theory. The cloud model not only reflects the uncertainty of the concept of the natural language, but also reflects the relationship between randomness and fuzziness, and constitutes a mutual mapping between the qualitative and quantitative(De-Yi et al. 1995). In knowledge management practice, we try to adopt the cloud model to identify and extract knowledge of open innovation.

Bin et al. (2011) were systematically summarized the research work of the cloud theory, here will not repeat them. But we must know that normal cloud model by the specific structure of expectations, entropy and hyper entropy generator to generate the qualitative concept and quantitative conversion value, reflecting the uncertainty of the concept. This particular structure is not only to relax a prerequisite for the formation of a normal distribution, but also relax from accurately determining the membership function to constructing expectation function of normal distribution membership, therefore is more general applicability, and is more simple and direct to complete interaction conversion process between qualitative and quantitative (De-Yi and Changyu 2004).

Normal cloud model can be expressed as follows: Let U be quantitative domain of a precise numeric representation, C is the qualitative concept of U, if the quantitative value $x \in U$, and x is a random realization of a qualitative concept C, if x satisfies: $x \sim N\left(Ex, (En')^2\right)$. Among it, $En' \sim N(En, He^2)$, and x satisfy the relationship for the degree of certainty C as in (82.1):

$$\mu = e^{-\frac{(x-Ex)^2}{2(En')^2}} \tag{82.1}$$

The distribution of x in the domain U is called the normal cloud. Cloud droplets which contribute to qualitative concept C in U have 99.7 % fall on the interval of $[Ex - 3En, Ex + 3En]$, and contribution to qualitative concept of the cloud droplets

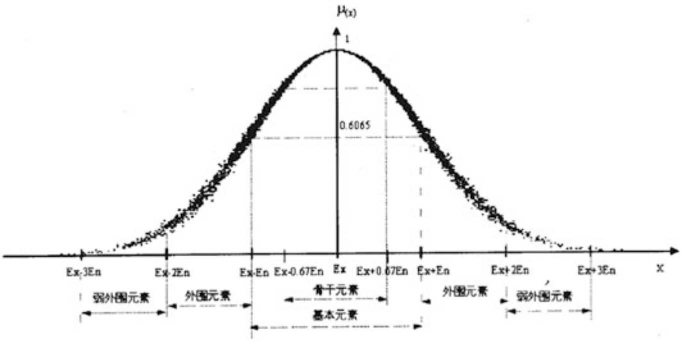
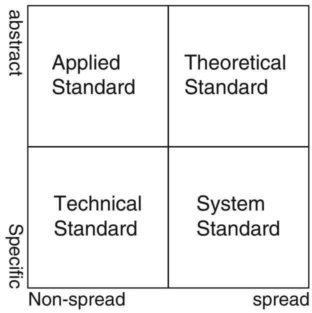


Fig. 82.3 Normal cloud model examples of analysis (*Data from* Changyu et al. 2004)

outside the interval of $[Ex - 3En, Ex + 3En]$ is a small probability event, could be negligible, which is the "$3En$ rules" of normal cloud (De-Yi 2000).

Changyu et al. 2004 have proved that using normal cloud model to represent uncertain knowledge is rationality and effectiveness (see Fig. 82.3). Here in the practice of open innovation, use normal cloud model to analyze the standard of knowledge extraction. We could extract the standard from knowledge, and make standard divided into four groups, that is (applied standard, theoretical standard; technical standard, system standard; special standard, public standard; specific standard, general standard) (see Figs. 82.4 and 82.5), which in accordance with two dimensions of the eight knowledge properties corresponding to the foregoing. Then, we can classify the knowledge of the standard extraction and store into standard framework or standard system, to provide an initial demonstration for the formation of standards and standard system (Changshun and Yijun 2007) (note: classification of standard in innovation knowledge here is different from the former, and the nouns of these standard categories are not very standardized, for an instance, "specific standard" should be "detail specification", do so because that this paper would like to make classification of standard correspond with innovation knowledge, in order to help everyone to understand and apply).

Fig. 82.4 Standard Type 1 of innovation knowledge: *Data from* author drew



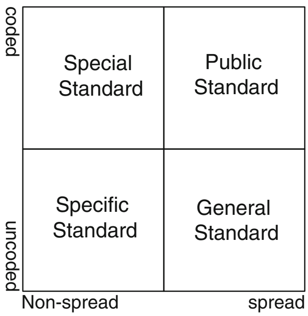


Fig. 82.5 Standard Type 2 of innovation knowledge: *Data from* author drew

82.3 Optimization and Transfer of Innovation Knowledge by Standardization

82.3.1 Theoretical Analysis

Companies involved in the process of technical standardization is the process to understand and master the development technology of product, is a process to solve technical problems by its own knowledge accumulation and organizational resources, so the companies which propose standard can put the development of new technology system into technical track, thereby more likely to gain an advantage in the later product competition.

Standardization reflects the accumulation of the knowledge base, and they, in turn, will generate feedback to R&D to promote innovation output. Standard application and a variety of feedback loops play a key role in the process of research and innovation, that is, knowledge transfer to the next generation of R&D through the standard. In the open innovation process, a lot of knowledge must be filtered and structured by standardization principles which would be detailed and fixed to enhance the quality of intellectual capital.

For explicit knowledge, the standardization process is designed so that knowledge of the user could quickly search for the required knowledge, for instance, we could standardize the product design process knowledge by standardization, unify concept and its relationship statements, provide a standardized language for different knowledge background and different level of staff to reduce or eliminate the confusion of the concepts and terminology, thereby reducing friction and misunderstanding costs in the process of knowledge transfer, and accelerating the design between the effective exchange, sharing and reusing of experience knowledge. Therefore, to the accumulation of existing knowledge, standardization is an important means which has been confirmed in practice.

But for tacit knowledge, knowledge transfer will generate more uncertainties, and even greater risk to innovation. More importantly, the environmental conditions and maturity may be not clear to the later stage, application feasibility and realization way of tacit knowledge may be unpredictable to the previous stage.

This is information incomplete of standardization existing in the knowledge transfer. In deeper level, this uncertainty and incomplete is due to the changes of knowledge property. Specifically, in the process of knowledge transfer, regardless of the tacit knowledge or explicit knowledge, knowledge properties continue to change, which include the increase, reduce or turnover of the property. Therefore, we would like to solve this problem by using of multi-attribute decision theory in practice.

82.3.2 Model Analysis

On the basis of previous research, taking into account open innovation process, knowledge management and standardization work has emerged features as multi-attributes and information incomplete. In practice, we use multi-attribute decision making under the conditions of incomplete information, the standard extraction of knowledge for sorting, filtering and structured. At present, the multi-attribute decision making problems under complete information is almost complete. However, in complex systems engineering management practice, most of the information has the property of inaccurate, incomplete and vague, coupled with the limitations of managers understanding of the problem or their own lack of knowledge of other reasons, program attribute values and attribute weighting coefficient information which managers are given or acquired is incomplete. Especially a lot of technical and management elements are uncertain, even subject to change at any time. Therefore, based on previous research results, we could apply multi-attribute decision-making method in the innovation knowledge with incomplete information (Sa-ru and Ha 2010).

82.4 Management and Diffusion of Innovation Knowledge by Standardization

82.4.1 Theoretical Analysis

Through standardization of technical experience will be accumulated to form the basis of the emergence of new technologies, to promote technological innovation. Multi-technology competition will lead to the uncertainty of the future, resulting in technology in the market cannot be quickly accepted by consumers, although a number of technical co-exist, but had not made great progress in the plight of. Technical standards can reduce this diversity through its coordinating role, greatly reducing the technology of friction between the social benefits of the huge loss. But also by enhancing consumer confidence, to become the standard technology quickly dominate the market, so as to promote the development of the technology and technical standards as a mature technology system, can make better technology products compatible with to further promote the development of complementary or compatible products. Companies involved in the technical standardization process at the same time understand and master the technology of product development process is the accumulation of knowledge and organizational resources to solve technical problems, the proposed standard to the development of new technology system included in the technical track, thus more likely to gain an advantage in the later product competition.

An important role of standardization is to make chaotic technological innovation into a system of technological innovation activities, and the formation of new markets. The success of innovation depends on the match and synergy between the factors, the important role of technical standards is to coordinate the business independently complete a variety of technological innovation and by given a comprehensive and systematic framework, making the chaotic innovation to a systematic way into the system of science, technology and industry play a joint role, provide a useful service for end users, and can open up new markets for the participants or partners to bring changes in the vitality to the industrial structure. Open innovation, standardization can ensure the integration of technology and innovative modular, generic, serialized, you can ensure that the technology and innovation interface interoperability, interconnection, complementary, you can ensure that the overall standard of the independent innovation in the system progressive realization within the system framework, to ensure a variety of innovative sources of the final integration into the scientific research achievements with independent intellectual property rights. Therefore, the coordinated development of open innovation needs to be in close connection with standardization, and to form systemic innovation by internal and external technical modular, innovative synchronized and coordinated to improve the role and status of China's technical standards.

82.4.2 Model Analysis

According to the multi-attribute decision making, we can get specific innovative stage, sort of the main series of standards for different object structure model. As mentioned earlier, if we integrate these standards and their elements together, then due to the different standard attribute assignment of different objects in different stages of innovation, leading to various standard elements may overlap, conflicting and uncoordinated. Therefore, we can, consistent iterative model, making and group decision-making matrix between acceptable similarity of individual decision-making matrix is constantly being adjusted until acceptable similarity between the group decision-making matrix, in order to amend the Multiple Attribute Decision Making matrix (Ying-jun and Dong 2010).

Typically, the selected principal component analysis and factor analysis is to establish and optimize an effective way of standard systems and standard development frameworks. Correlation coefficient matrix of the starting point of these two methods are variable, in less loss of information under the premise of multiple variables (these variables requires the presence of strong correlation, in order to guarantee the principal components extracted from the original variables) integrated into a few variables to study all aspects of the overall multivariate statistical methods, and this small number of several variables represent the information can not overlap, that is variable between unrelated. The principal component analysis is the use of dimensionality reduction techniques using the few variables instead of the original multiple variables, variable focus most of the information of the original variables; scientific evaluation function score by calculating the integrated principal component, the objective economic phenomenon; information contribution to the influence of the comprehensive evaluation focused on the application. Factor Analysis is not the choice of the original variables, but according to the information of the original variables to regroup, to identify common factors affecting the variable, the simplification of data, abandoning the special factor (Yang 2011).

Open innovation and technology diffusion process in a variety of needs of the standard preliminary classification of the eight attributes of the previous standard for measuring the actual situation of the technology development and application of experimental and market demand, the needs of the different criteria in observations in these eight attributes, is X_{ij} $(i = 1, 2, \cdots, n; j = 1, 2, \cdots p)$. As a result, we can get the following matrix as in (82.2):

$$X = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1p} \\ x_{21} & x_{22} & \cdots & x_{2p} \\ \vdots & \vdots & \ddots & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{np} \end{bmatrix} = \left(X_1, X_2, \cdots X_p\right) \tag{82.2}$$

Among it $X_1 = (x_{1i}, x_{2i}, \ldots, x_{ni})', \quad i - 1, 2, \ldots, p.$

Then, the application of factor analysis based on multi-attribute decision-making information, various standard view re-combination to identify common factors affecting the variable defined in the standard division of clear criteria for classification, to improve the standard system, so as to open innovation, knowledge management more optimized knowledge structure and knowledge level.

82.5 Conclusion

In summary, open innovation can receive a higher innovation output by less investment and lower costs in research; but also it may face a huge risk, and risk investment of market operation. Knowledge is becoming a key factor in determining its success or failure as the most important resource of innovative activities. In the practice of open innovation, knowledge management has become a new model to replace the traditional product innovation management. Standardization work is not only an effective way of knowledge extraction and accumulation in innovation management, but also to provide a development framework for knowledge management, and to optimize the structure and level of the knowledge management, to improve management efficiency. On the other hand, standardization work could not only provide knowledge input for open innovation, but also promote open innovation through knowledge transfer in the whole process of innovation by standard as a media; not only curing the innovative technological achievements, but also promote innovation technology diffusion. This article asserts: according to the needs of open innovation and knowledge management characteristics, through the reasonable, advanced scientific modeling tools integrated into standardization work, then standards is not only the most effective connecting link between open innovation and knowledge management, but also the multiplier to promote the common development of both.

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Chapter 83
Study of Knowledge Diffusion FSAI Model for High-Tech SMES Clusters

Su-ping Zhou

Abstract Knowledge diffusion is a spiral cycle experience, which including knowledge formation, knowledge spillover, knowledge absorption and new knowledge formation. The paper constructs a knowledge diffusion FSAI model for high-tech SMES clusters, focuses on influencing factors to three stages of knowledge spillover, knowledge absorption and knowledge innovation.

Keywords High-tech SEMS clusters · Knowledge diffusion · FSAI model component

83.1 Knowledge

The "knowledge" entry in « Encyclopedia of China • education » (1985) is stated as "The knowledge, which reflects to its content, is reflect of property and links of objective things, the subjective image in the human brain of objective. To its activity form, it sometimes expressed as things' emotional perception or appearance by subject, which is perceptual knowledge; sometimes expressed as things' concept or rules, which is rational knowledge."

The characteristics of knowledge including tacit characteristic, action-oriented characteristic, dynamic characteristics, subjective characteristics, copy/transfer characteristics, extend growth characteristics, capital characteristics, double characteristic, skilled characteristic, situational characteristics, mental-accepted characteristic, results-oriented characteristic, power characteristics, life characteristics, etc.

S. Zhou (✉)
School of Economics and Administration, Tianjin Open University, Tianjin, China
e-mail: zhousptj@126.com

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83.2 Construction of Knowledge Diffusion FSAI Model for High-Tech SMES Clusters

Academic circle has much different definition on knowledge diffusion; this paper considers that knowledge diffusion is a continuous cycle and spiral process, including knowledge formation, knowledge spillovers, knowledge absorption, and knowledge recycling until the new knowledge formation.

Knowledge diffusion in high-tech SME clusters is a cycle process with spiraling trend, including knowledge formation-knowledge spillover-knowledge absorption-knowledge innovation-new knowledge formation, showed as Fig. 83.1.

83.2.1 Knowledge Formation

Knowledge formation refers to the subjective image's formation of feeling, concept or regularity of properties and contact of objective things. Knowledge may be formed by means of knowledge production and practice, social practice and scientific experiments. Knowledge formation in high-tech SME cluster is the result of various factors in the cluster work together.

83.2.2 Knowledge Spillover

Knowledge spillover is knowledge or information flow from one department to another within the organization, or the state and process flow from the organization internal to the organization external. According to the process, knowledge

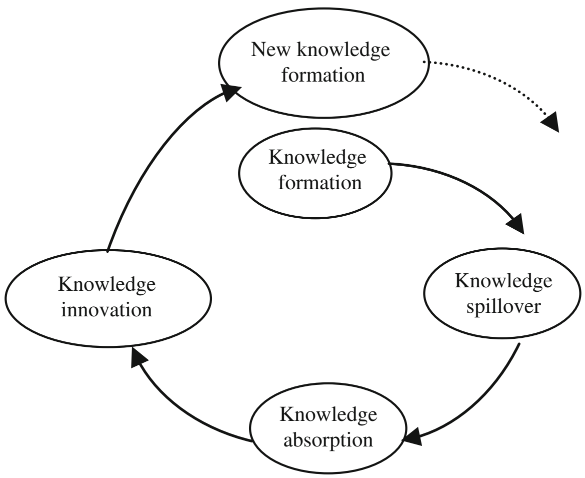

Fig. 83.1 Knowledge diffusion FSAI model for high-tech SMES clusters

spillover can be divided into horizontal and vertical. The horizontal refers to knowledge spill among similar enterprises or research institutions; the vertical refers to knowledge spill among different types of enterprises and research institutions. The horizontal spillover will generate scale economic, vertical spillover will generate scope economic (Huangbao 2008).

Knowledge spillover effect is the manifestation of knowledge spill, which is represented as the knowledge innovation caused by knowledge receiver or demander digest and abort external spilled knowledge.

Knowledge spillover effect is mainly in three aspects: knowledge spillover effect by itself; new market spillover effect created by knowledge; new benefits spillover effect created by knowledge. This paper mainly research from knowledge spillover effect by itself (Liu 2008).

Knowledge spillover effect mainly relates to the impact factors such as space, science and technology talents, knowledge staffs' flow, market structure and social network.

83.2.3 Knowledge Absorption

Knowledge absorptive capacity refers to the capacity of understanding, absorptive, digestion and application new knowledge.

Knowledge absorption can be studied from two levels: individual level and enterprise level (Yang and Huang 2009). This paper mainly studied from the enterprise level.

Enterprise knowledge absorptive capacity includes four categories: knowledge acquisition ability, knowledge acceptation capacity, knowledge transfer capacity and knowledge development and utilization capacity. The knowledge acquisition capacity refers to judge and get knowledge which plays critical role to enterprise; the knowledge acceptation capacity emphasizes effectively interpret and understand external knowledge, knowledge that couldn't be understood is difficult to be recycled and developed; knowledge transfer capacity is effective integrates internal and external knowledge; knowledge development and utilization capacity refers to develop new knowledge by common use internal and external knowledge. The four capacities can be classified into two categories: knowledge potential absorptive capacity (including knowledge acquisition and absorption) and knowledge practical absorptive capacity (including knowledge transfer and exploitation). Knowledge potential absorptive capacity is the premise of enterprise using external knowledge. Knowledge practical absorptive capacity is the key of enterprises' continuous innovation and maintaining competitive advantage through making use of external knowledge (Liu 2009).

83.2.4 Knowledge Innovation

Knowledge innovation is a systematic process that constantly applies and innovate knowledge to new areas under closely related to economic development and knowledge accumulation through knowledge management. The purpose of knowledge innovation is to pursuit new discoveries, explore new laws, create new theories, create new methods and accumulate new knowledge. Knowledge innovation is the foundation of technological innovation, the sources of new technologies and new invention, the revolutionary forces to promote technological progress and economic growth. Knowledge innovation includes concept innovation, technological innovation, system innovation, management innovation, cultural innovation and so on. Knowledge innovation within the cluster is mainly applied research; the purpose is to develop new products for market or cost saving by using new technologies.

83.2.5 New Knowledge Formation

New knowledge formation is giving existing knowledge new understanding, feeling, concept or regularity based on the existing knowledge, in the process of knowledge spillovers, knowledge absorption, especially in knowledge-recycling. New knowledge formation is the starting point for the next FSAR.

83.3 Different Stages of the FSAI Model

We mainly study the three stages of knowledge diffusion in high-tech SME cluster: knowledge spillover, knowledge innovation and knowledge absorption. The main influence factors in each stage are as follows:

83.3.1 Knowledge Spillover Stage

The main influence factors of Knowledge spillover stage are space distance, the aggregation and mobile of knowledge staff, the market structure and social network.

83.3.1.1 Space Distance

Explicit knowledge diffusion mainly through the mass media, Tacit knowledge diffusion must through face-to-face communication, therefore, the dissemination cost of explicit knowledge relate to distance, but the dissemination cost of recessive knowledge is a distance attenuation function. Therefore, knowledge spillover is influenced by certain space limits.

Caniels (2000) put forward space knowledge spillover hives model, through introducing the "learning in work" concept in the theory of the new economic growth. M. C. J. Caniels put the "learning in work" effect into knowledge spillover research scope, constitute a knowledge spillover hives model based on hexagon regional spatial, such as the Eq. 83.1.

$$S_i = \delta_i / r_{ij}\, e^{-\left[1/(\delta_i)\, G_{ij} - u\right]^2} \tag{83.1}$$

S_i is knowledge spillovers effect of i area accepting j area. δ_i is the learning capacity of i area; G_{ij} is knowledge stock gap between area i and area j, γ_{ij} is geographic distance between area i and area j; μ is technological catch-up coefficient, which refers to knowledge stock gap be realized technology catch-up between two area. When area number add to k, for each area, weigh knowledge spillovers acceptable by the area need to measure by accept knowledge spillovers aggregation from $k-1$ area, such as the Eq. 83.2.

$$s_i = \sum_{j=1}^{k-1} \delta_i \Big/ \left(r_{ij}\right) e^{-\left[1/(\delta_i)\, G_{ij} - u\right]^2} \tag{83.2}$$

The Chinese scholars Zhu and Han (2008) were established a correction model based on the regional knowledge ability, this model is replacement and improve for knowledge stock, technical distance and knowledge absorptive capacity of M. C. J. Caniels' model.

$$\dot{s}_{ij} = \Delta_i / \left(\dot{R}_{ij}\right) e^{-\left[1/\left(\Delta_{ij}\right) G_{ij} - u_i\right]^2} \tag{83.3}$$

$\dot{S}_{ij}$ is knowledge spillover effect value of region i accept region j; Δ_i is knowledge absorptive capacity of region i, G_{ij} is knowledge capacity gap between two region; $\dot{R}_{ij}$ is the space distance between region i and region j (contain region near degrees impact); μ_i is technological catch-up coefficient, which refers to knowledge stock gap be realized technology catch-up between two area. Hypothesis there are k research regions, such as the Eq. 83.4.

$$S_i = \sum_{j=1}^{k-1} \left(E_i \times E_j\right)^{\varepsilon} \left(F_i \times F_j\right)^{\eta} \delta_i\, \xi^{W_{ij}} / \left(R_{ij}\right) e^{-\left(1/(\delta_i)\, G_{ij} - u\right)^2} \tag{83.4}$$

The Study whatever by M. C. J. Caniels or Chinese scholar ZHU Meiguang have demonstrated that knowledge spillover effect among enterprises is inversely proportional to the distance. While the study of Chinese scholar ZHU Meiguang shows that information convenience and traffic convenience are relate to space distance, namely the smaller space distance is, the stronger information convenience and traffic convenience will be. So in fact, the influence that space distance on knowledge spillover effect is greater than inverse correlation.

Geography adjacent causes the direct interaction effect among adjacent consumers, suppliers, competitors and education and research organization. Direct interaction helps to obtain knowledge, especially the recessive knowledge. While a prerequisite of enterprises cluster is space gather, namely exists on the same geographical area, space distance were comparatively small. Therefore, it will be helpful for knowledge spillover.

83.3.1.2 Knowledge Staff Aggregation and Flow

The concept "knowledge staff" was first proposed by American scholar Peter F. Drucker, specific refers to "The staff that masters and applies the symbols and concepts, works using knowledge and information". Now knowledge staff generally refers to the staff who engage in activities that production, creating, extension and application knowledge, brings knowledge capital appreciation for the unit (or organization), and takes it as a profession Knowledge staff's aggregation.

Niu et al. (2010) studied the effect that knowledge staff's aggregation to knowledge spillover effect. Knowledge staff aggregation phenomena refers to in a certain period of time, with the flow of the knowledge staff, the clustering phenomenon formatted by the same type or related personnel according to certain rules, in a particular area (physical space) or to a specific industry (virtual space). Knowledge staff aggregation phenomenon will produce economic effect. Knowledgeable staffs that have certain relation, aggregated in a certain area, play more than independent function of aggregation effect under the action of harmony internal and external environment.

Knowledge spillover's economical effect is positive effect, namely knowledge spillovers subject will spread out all or part of knowledge properly to share with others; transmission medium comprehensive classification and screen knowledge, what make the knowledge spreader to knowledge accept subject more effective. Knowledge effectively knowledge accepted subject able to correctly identify, receive and use the information to create knowledge accumulation, and innovate knowledge on the basis.

Science and technology talents aggregation effect can be divided into organization effect, environmental effect and aggregative members effect of themselves; and can be specific divided into: information sharing effect, knowledge spillover effect, innovation effect, collective learning effect, incentive effect, time effect, regional effects and scale effect.

Knowledge spillover effect is concerned to knowledge spillovers subject, knowledge spillover strength and knowledge spillovers content. Knowledge spillovers subject in high-tech SMES clusters are knowledge staff, each knowledge staff plays the dual role of knowledge spillover subject and knowledge accept subject. Enterprise cluster not only can shorten the communication distance, reduce communication cost; but also can reduce communication link, reduce knowledge lost, twisted and distortion phenomenon in communication, quicken the propagation speed of Tacit knowledge, guarantee the authenticity of implicit knowledge transfer. For the Tacit knowledge, characteristics of high-tech SMES knowledge staff concentration, convenient communication, random interview and the secrets of the tacit knowledge, decide the tacit knowledge overflow content have the characteristics of anytime, concentration and dynamic under knowledge staff aggregated.

(a) *Knowledge staff's flow*

Nan (2009) considered that regional innovation level and personnel flow is the positive correlation through a study on the computer industry talent's flow in Silicon Valley. He established a dynamic knowledge connection model for regional talent flow, assuming that there are only two types of company in high-tech technology industry: suppliers and manufacturers, the number of employees from manufacturers flow to suppliers.

$$\frac{S}{E} = \frac{(1-\tau)\gamma}{\tau(x + (\varpi + k))} \tag{83.5}$$

S is suppliers number in region; E is producers number in region; r is innovation level, x is expected profit level of suppliers conversion; τ is manufacturers' benefit due to innovation in each phase; $(1-\tau)$ is suppliers' benefit; $(\varpi + k)$ is expenditures to recruit experienced employees.

The Eq. 83.5 can state that the greater the number of suppliers and manufacturers business relations has, the greater turnover ratio between the supplies and manufacturers in cluster region.

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83.3.1.3 Market Structure

To emerging industry, enterprise scale is not large, knowledge spillover is very important to these enterprises. These enterprises usually have less scale compared with mature companies. On the other hand, they have capacity of large-scale R&D activities, and market monopoly helps them get high innovation economic profit. Monopoly also hindered the knowledge spillovers, so only through the externality internalization (knowledge sharing) can realize synchronous development of innovation and economic growth.

The industry which high-tech SMES clusters in usually is the immature new industry. It is relatively limited that R&D personnel, money and capacity, therefore, the needs of knowledge sharing and knowledge spillovers are more intense.

83.3.1.4 Social Network

Some scholars emphasized the importance of the social network in geographical area. Stable and reliable reciprocity social network's forming conducive to scientific and technical staff's interaction, promoted the knowledge's overflow and spread. A study on experience of Silicon Valley and Boston by Nineveh shows that stable social network among enterprises increased enterprise innovation ability, reduced the transaction costs.

Wu and Li (2004) considered usually it has more advantageous that non-compete enterprise gathered in the same technical field through the study of the technology incubation enterprise knowledge spillover effect. If competition cost less increase with scale growth, enterprise's best gathered scale will be increased while the increase extent of competitive enterprises assembling is larger than the knowledge spillover increase extent caused by knowledge construction change. Conversely, if the best gathered scale enterprise be reduced, and the enterprise cluster effect has little change, but competitive cost increase larger, then enterprises gather hasn't efficiency. The conclusion is that knowledge learning and communication among enterprises' produced knowledge spillover effect. Only enterprises gather can share its non-coding knowledge and produce knowledge spillover effect. If the technical knowledge proportion of competitive enterprise is larger than non-competitive enterprise in the same technology field, knowledge spillovers effect will be larger, but because of their competition, gathered cost will be bigger, overflow efficiency may be lower, what depending on the knowledge structure and the knowledge output characteristics. Therefore, it will be more effective that non-compete enterprise gathered in the same technology field.

83.3.2 Knowledge Absorption Stage

The main Influence factors of knowledge spillovers effect in knowledge absorption stage depends on some of knowledge absorption enterprise's own characteristics, including: enterprise R&D activities, enterprise learning culture, enterprise sensitivity for new knowledge, enterprise knowledge accept ability and cluster learning mechanisms.

83.3.2.1 The Enterprise R&D Activities

Knowledge absorption enterprise can be divided into two types (Yang and Huang 2009): one is "research center" type, enterprises gather in a particular area are engaged in the research and development activities, the same enterprise can not only be the knowledge spillover, but also may be the recipient, knowledge flow is a of two-way, such as the silicon valley. Another is the "technology source" type, namely flow of technical knowledge is one-sided, from leaders to imitator.

Obviously, enterprises in high-tech SMES clusters more accord with characteristic of "research center" type, can effectively promote knowledge absorptive capacity. It is because as follows: firstly, the organization absorptive capacity is the sum of individual absorption ability, innovation activities absorb or train large quantities of high quality professional talents for enterprises, these high-quality talents absorbing and digesting external professional knowledge helps to promote enterprise's whole absorptive capacity. Secondly, the innovative activities and how much the R&D input will influence on learning motivation of members, also influence on the knowledge spillovers learning easy degree and quantity of obtainable knowledge; Thirdly, R&D activities will improve technical opportunity condition, more technical opportunity means more external information, which will enhance motivation of enterprises build absorptive capacity, and a more challenging learning environment also can enhance motivation of the R&D activities to build absorptive capacity, so there is mutual promoting role between R&D activities and absorptive capacity.

83.3.2.2 Enterprise Learning Culture

Enterprise learning culture determines staff's learning motivation, enterprise with good learning culture has strong knowledge communication and coding ability, namely performance skills of knowledge source such as clearly express, good language expression, and easy to be understand (Liu and Xie 2003). Communication skills make enterprises interaction and relationship be developed, can capture a variety of knowledge spillovers opportunity. Learning culture makes staff's learning motivation relatively intense, the behavior overflow knowledge learning and sharing will be encouraged, may also play a role to strengthen willing of the individual learning overflow knowledge, and devote more energy to improve knowledge spillover effect.

83.3.2.3 New Knowledge Sensitivity of Enterprise

There is correlation between new knowledge sensitivity of enterprise and knowledge spillover effect. Knowledge receiver sensitivity directly determines the quality and flow of direction overflow knowledge. Whether knowledge receiver realize the leading knowledge and whether there is definite strategic intention to absorb knowledge from knowledge source affected active degree of absorb knowledge by knowledge receptor. Once knowledge receptor be aware of external knowledge and think it has a strong market potential, the stronger consciousness of knowledge absorption by knowledge receptor is, the easier the knowledge spillover will be.

83.3.2.4 Knowledge Accept Capacity of Enterprise

Through empirical research, Agra Walter confirmed that there is correlation between knowledge spillovers effect and, absorption and application capacity of new knowledge by economic subject cognition of accept overflow. The absorption and application capacity of new knowledge depends on the necessary preparation knowledge of accept subject. External knowledge absorption and application capacity of an enterprise is closely related to what the enterprise has knowledge endowment and knowledge connotation by itself, only the enterprise have the corresponding precedent knowledge can digest and applicator new knowledge. Accept subject accepts ability also and spillover between subjects related technical similarity. By defining technology integrated index, Jeff studied the influence on adjacent enterprise technology distance under the condition of knowledge spillover, technology distance significantly affect enterprise innovative activities. Excessive technical distance makes knowledge absorption enterprises haven't platform to digest absorb new knowledge and technology, While technology distance is too small will make knowledge spillover space is too small. Therefore, keep a proper technology distance will produce stronger knowledge spillover effect.

83.3.2.5 Cluster Learning Mechanism

Generally speaking, organization learning can be divided into internal learning and external learning. Internal learning refers to knowledge diffusion and the knowledge innovation activities within the organization, and external learning refers to the technology imitation, transfer and introducing. If cluster is an organization, the cluster knowledge absorption in addition to including absorb new knowledge outside cluster, still including new knowledge diffusion, use and re-innovation within a cluster, so it is a kind of integration of external learning and internal learning. Therefore, more technical exchanges, academic BBS activities should be undertake in cluster. We should create opportunities for knowledge circulation and share, promote enterprise cooperation R&D project activities, and establish cluster learning mechanisms.

83.3.3 Knowledge Innovation Phase

83.3.3.1 Knowledge Innovation Subject

Knowledge innovation subject is the enterprise within a cluster, but for high-tech SMES clusters, on one hand, owing to the resource constraints, SMES enterprises often are ambition in knowledge innovation, on the other hand, high-tech industry requirements that knowledge innovation is frontier innovation, it is difficult to innovate. High-tech SMES clusters internal knowledge innovation must by means of scientific research institutes, and according to the high-tech enterprises cluster has formed view, cluster surrounding are concentrated several research institutes, even some cluster were already formed with research institutes as center in geographical position. To cluster, it is important to university-industry cooperation, put the knowledge innovation into application. The mutual trust culture in cluster based on frequent communicate and exchange transactions makes organization whose business exists on similar or complementary are easily formed cooperation, cooperative innovation of organization formed by different innovation subject will cooperative innovate for a certain market opportunity (Zhang and Zhang 2006).

83.3.3.2 Infrastructure

Infrastructure provides good external conditions for knowledge innovation behavior within cluster. The infrastructure which be used in knowledge innovation process, such as library, knowledge base within the organization and organizational, be established based on the Internet and Intranet technology, the experimental conditions and equipment to be used in the knowledge innovation process.

For any organization is concerned, it is impossible to have all knowledge and its related infrastructure in its business scope. Due to its internal members business contact and complementarily, cluster could obtain its necessary knowledge and facilities conveniently and economically by means of free or pay, in knowledge innovation behavior, at the same time, the subjects who own knowledge and facilities knowledge production institutes (university and research institutes) also improved its utilization ratio of facilities and knowledge, the fixed cost be shared.

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Chapter 84
Research on the Difficulties and Development Strategy for the Construction of Innovative Enterprises

Xin Zhu and Ying Li

Abstract The goal of this paper is to analyze the content and characteristic of innovative enterprise, the difficulties for the construction of innovative enterprise and the countermeasures for the implementation of innovative enterprises construction. Firstly, we make an introduction about the definition of innovative enterprise, and also make an analysis about the characteristics such as the strong spirit of innovation, the strong conditions for innovation, the systemic innovative content, and the continuous innovative activity. Then, we make a discussion about the difficulties and problems for the construction of innovative enterprises. Finally, we put forward the strategic routes and corresponding suggestions for the health development of innovative enterprises to realize their core competitiveness.

Keywords Innovative enterprise · Existing problems · Development strategy

84.1 Introduction

With the interaction of the economic globalization and the new technological revolution, the scientific research went into the unprecedented depth and breadth. There are breakthroughs in breeding high-tech cutting edge, technological innovation and bring new technology base and the rise of new competing industries,

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X. Zhu (✉) · Y. Li
School of Management, Guangxi University of Technology, Liuzhou, China
e-mail: zhuxinjupiter@hotmail.com

Y. Li
e-mail: 5266736@qq.com

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and profoundly affect the global economic and social development. The Chinese market has attracted global multinational companies and innovative companies competing to landing this piece of land for the future potential. In the next 15–20 years, it will be an important period of development, but also a battle of fierce competition for China. The enterprises are standing in the front line for market competition, and the enterprise's core competitiveness will determine the competitive success or failure. The core competence is the decisive factor for independent innovation. It is the historical mission for the innovative companies with Chinese characteristics using of favorable conditions for reform and opening up, to cultivate their own intellectual property industries, and create its own well-known national brands (Baldwin and Clark 1992). It is also the key step for the building an innovative country in the near future.

Enhance independent innovation capability and building an innovative country is an important national strategy. A large number of high level innovative groups of enterprises are an important foundation of support to build an innovative country, and are the decisive force for the building of an innovative country. Full implementation of the innovation and development strategy and accelerating the building of innovative enterprises, creating a large number of strong independent innovation capacity and strong international competitiveness and innovative group of enterprises are the basic projects and tasks for building an innovative country. It is also the major strategic choice for the Chinese company to deal with economic speed up the process of globalization and international and domestic complex, increasingly competitive environment (Hu and Jiang 2008). In today's world, the developed countries of their international competitiveness, mainly reflected in the master core competitiveness of innovative companies who developed the world's economic power and innovation-oriented country, it is also has a number of innovative enterprises benefited from the support and lead the group. Innovative enterprises are the dominant force in international competition. The future of China's technological and economic development will depend in large part to a large number of innovative business groups with strong independent innovation capacity and strong international competitiveness, which can stand in the international industrial development and lead the world economic development (Lazonick 2003).

84.2 The Content and Characteristic of Innovative Enterprise

The innovative enterprises refers to the enterprises treating innovation as the driving force for the development, applying all production factors to actual course of business, integrating the internal and external resources and creating value for customers. The understanding of innovative enterprises must grasp the following four aspects: the innovative enterprises treat innovation as the power for enterprise development; the innovation should be a continuous innovation; the innovation is a comprehensive and collaborative innovation; the ultimate goal is to create new value or economic profit through the operational. The Innovative enterprises have distinct external features with the traditional enterprise. The characteristics of innovative enterprises are as follow.

84.2.1 The Strong Spirit of Innovation

Innovative enterprises are actively engaged in innovation activities, and have strong desire and motivation for innovation. The enterprises can form technical and economic advantages, and further enhance corporate organization and coordination, marketing, resource integration, innovation management, integrated capabilities, thereby enhancing the overall strength of competition in the market, thus enhancing sustained innovation capability of enterprises and promote the sustainable development of enterprises through continuous innovation activities and innovation accumulation. Entrepreneurs are leading innovation and organizers, so innovation depends largely on the desire of the spirit of entrepreneurial innovation, which includes awareness of sustainable development and green innovation, scientific management self-concept and self-concept, initiative, pioneering spirit, risk taking, and so on. The innovative entrepreneur will result in the effective technological innovation, market innovation, and management innovation (O'Sullivan 2000). The unique c innovation culture will from only when all of the staff generally recognized innovative ideas and awareness of entrepreneurs.

84.2.2 The Strong Conditions for Innovation

If the enterprises can't possess the conditions for innovation, innovation activities will not be carried out, of course, let alone to mention the construction of innovative enterprises. These conditions include: design a reasonable and feasible goal of innovation development strategy and its implementation program, with enterprises engaged in innovation activities required for innovation system, innovation agencies, creative talent, R&D organization and its management organization, innovation and social communication networks, financial resources and material resources, knowledge, technology and information resources, with innovative resources for these rational and efficient access, processing, use of comprehensive ability. The enterprises can operate and sell the rights to develop monopoly prices for excess profits. The enterprises can greatly enhance brand value, effective market development, expand sales and use strategies to obtain high economic returns through the long-term accumulation of innovation and brand image (Jiang 2005). In this way, the enterprises will accurately grasp the investment opportunity to achieve rapid growth in wealth through mergers and acquisitions, asset restructuring, joint venture, investment shares and OEM production methods using their intellectual property and advantages.

84.2.3 The Systemic Innovative Content

The innovation in innovative enterprises is a systematic project, involving at all levels, all sectors and all parts of the internal company, such as the concept innovation, talent innovation, knowledge innovation, system innovation, management innovation, strategic innovation, brand innovation, technological innovation, product innovation, marketing innovation, and market innovation. Innovation in every aspect of plays their unique role: management innovation and system innovation is a guarantee of innovation; strategic innovation, the concept of innovation and talent and innovation is the fundamental innovation; technological innovation and knowledge innovation is the key to innovation; product innovation and brand innovation is the carrier of innovation; market innovation and marketing innovation is the implementation of enterprise innovation. There are close relationship between them, together constitute the full range of multi-functional innovation. In addition, innovation is the dominant production activities across the enterprise, business activities, and management activities of the center. There is a direct or indirect contact in each level of the enterprise, each of the sessions, each department and each employee's work and innovation.

84.2.4 The Continuous Innovative Activity

The continuous innovation is the essential characteristics of innovative enterprises, only the enterprises which can achieve continuous innovation can be truly innovative enterprises. Innovative companies not only to achieve development in good times, but also can survive in the face of adversity and development; not only in the short period of time to achieve development, but also in a longer period to seek sustainable development. From the systemic innovation in terms of innovation within innovative companies involved in all levels and in various links and various parts of the management innovation and system innovation, the concept of innovation and talent innovation, technological innovation and knowledge innovation, product innovation and brand innovation, market innovation and marketing aspects of innovation, but also to the survey, forecasting, decision-making, planning, research, design, production, management, marketing and finance and a series of process activities. Business innovation has been presented in the content and activities, as long as companies do not stop the run, innovation will continue. From innovation in terms of sustainability, innovation-oriented enterprises as the first successful innovation, it begins according to market demand and competition for the second innovation, and comprehensive information in the analysis and prediction based on the idea of the development trend of the first three innovations. The enterprises realized the idea generation, research and development generation, manufacturing and marketing generation to generation in technology innovation and product innovation. We can see that the innovation in such kinds of enterprises has been in a sustained state.

84.3 The Analysis on the Difficulties for the Construction of Innovative Enterprises

84.3.1 The Risk Forcing Innovation Stagnation is Very Huge for the Innovative Enterprises

The risk faced by the innovative enterprises is not a single risk, but the combination of risks, including environmental risk, technology risk, market risk and management risk (Jensen and Murphy 1990). The environmental risk is the gap between the change trend of the external business factors and the development requirements of enterprises. External factors associated with the major companies include policy, legal, moral, psychological, social media, and value orientation. Changes in these factors have their own rules and requirements, easily conflict with innovative features, and thus a negative impact on innovative enterprises. Technical risk is the existence of any one of these technologies is the possibility of alternative new technologies, the rapid development of information technology today, this possibility further enhanced, innovative companies will make a huge investment can not be recovered. Market risk is based on new technology products and services are not immediately recognized and accepted by the market, due to market demand, there is a certain inertia and fixed type, not only the existence of a recognized and accepted by the market process, and there may be rejected by the market, precisely because of its new, more likely to reject the market, once can not melt into the market, the value of innovative companies and interests will not get reflected. Management risk is the development of innovative enterprises in different stages of the corresponding conversion requires the organization structure, which means that the rights and interests of member companies of adjustment, will cause conflict and contradiction, so that innovative enterprises into internal chaos and unable to extricate themselves.

84.3.2 The Innovative Enterprises Lack a Reasonable Support for Enterprise System

The independent innovation capacity for China is weak, and the innovation progress is slow. Most of the enterprises don't have the positivity and capability to focus on the innovative activity. The major reason for such situation is the deficiencies in the system and imperfect management structure and mechanism. At present, most enterprises do not really establish a modern enterprise system.

Although a considerable number of enterprises operating mechanism for the conversion, the implementation of autonomy, joint-stock reform, the implementation of the corporate system, but most only stay on the surface, a mere formality, from the real goal of establishing a modern enterprise system, there is a big gap. The deepening of enterprise system innovation, the establishment of modern enterprise system is the fundamental protection to enhance the capability of independent innovation, build innovation-oriented enterprises, and realize the rapid and sustainable development of enterprises.

84.3.3 The Innovative Enterprises Lack the Innovative Corporate Culture as the Guarantee

Innovative corporate culture refers to the innovation has become the company's core values, innovative ideas have been generally recognized by the staff, people believe that only innovation, enterprises can survive and develop. Great emphasis on innovation and enterprise managers, and continue to promote innovation, enterprise management and the staff are a positive innovation, daring and enterprising, risk-taking, innovative ideas have permeated the consciousness of the enterprise up and down the depths of officers and employees have been translated into habits. Most of the enterprises from the domestic point of view, an innovative corporate culture in most enterprises is still weak in cultural status. Some of companies do not have the typical employee innovation behavior to guide the innovation culture. Most of the corporate culture phenomena come from the social cultural, their characteristics is not clear and the theme is not prominent, leading to social cultural influence exceeds the influence of corporate culture.

84.3.4 The Innovative Enterprises have Difficulty to Suite the External Environment

The innovative enterprises generally have strong vitality and creativity, but the external environmental factors are relatively stable, which makes conflict between the two become easy and common (Carpenter et al. 2003). There are three conditions: Firstly, the development of innovative enterprises needs to break the existing restrictions, but the stability of the existing environment makes the breaking be difficult. Secondly, changes in the environment has its own laws, it will not necessarily the direction of change and innovation to ensure that consistent with the requirements of enterprises. Thirdly, the main characteristic of changes in environmental factors is a gradual change. If the innovative enterprises lack the strategic vision, reveling in the success of an innovation, neglecting their continuous innovation capability, they will be eliminated by the changing environment. In the long term, innovative companies represent the future direction of economic and technological development, changes in environmental factors with the development of innovative enterprises requires coordinated. In the short term, innovative enterprises have conflict with the environment some time. If the innovative companies can not be reconciled the relationship with the external environment, they will get in trouble.

84.3.5 The Development of Core Technology for Innovative Enterprises Lack the Continuity

The core technology is the basis for the development of innovative enterprises, innovative enterprises should not only play a central role of technology, but also to promote the continued development of core technologies and improve the sustainable innovation. Many domestic enterprises to form the core technology for the first time after the stagnation of innovation, content with existing technology, not re-development of core technology, there is no research and development of relevant technologies, resulting in the gradual failure of core technology, technology gradually lost. The reason the one hand, inadequate attention to the continuous innovation, ability is not strong, the other for the first time the successful experience of innovation often cure the neglect of continuous innovation in the environment and requirements of the new changes, there is no actual market conditions for continuous innovation and even the development of technology and market direction to make the wrong judgments, so that the original core technology lost.

84.4 The Countermeasures and Suggestions for the Construction of Innovative Enterprises

84.4.1 We Should Insist on the Innovation Road for the Development of Innovative Enterprises

The development strategy is the long-term business development and the fundamental design and planning for the enterprises with the complex changes in the increasingly fierce competition and tough challenges for the realization of strategic goals (Lazonick 2007). Trend of economic globalization, countries, competition among enterprises is essentially a strategy of innovation and the innovation and development of competition. Creativity and innovation development strategy is the world's prominent features of international competition and competitive focus. Innovative Enterprises is a prominent feature of the innovation as the fundamental strategy to achieve sustainable development of enterprises through innovation. Innovation and development of innovative enterprise strategy is a systematic, dynamic, innovative, comprehensive, long-term and fundamental innovation and development of enterprise system design and overall plan, is built on the basis of continuous innovation in the enterprise to enhance independent innovation ability to achieve business innovation and development as the core. The core development strategy is the soul of enterprise innovation and development, determine the survival and sustainable development. With the speeding up of the process of economic globalization and intense change of international and domestic competitive environment, the innovative enterprises have to endure the unprecedented competitive pressures and challenges. The innovative enterprises should enhance their core competitiveness, and maintain a competitive advantage to achieve rapid, sustainable development.

84.4.2 We Should Attach Importance to the System Innovation and Perfect the Management System

Enterprise system is the principle mode of business operation requirements, is about the organization, operation, management and a series of norms and patterns of behavior. Enterprise system innovation is the continuous development of productive forces in order to meet changing needs, the organizational form of the corresponding changes. In-house technical staff should be established to play a benefit to the decision-making system, personnel system, financial system, property system, distribution system, intellectual property protection system. At present China's modern enterprise system innovation is the key property rights clearly established separation of enterprise management science, business property in the clear attribution of the source and the economy on the basis of determining the dominant position of corporate property right. We should truly establish a modern enterprise system the investors, board of directors, managers, supervisors and other internal and external roles of the rights and responsibilities. We should change the decision-making by the fact the owner—the industry and local government authorities to decide, not passed by shareholders on behalf of the status of the general assembly. We should also really separates the distribution system and the distribution should be implemented according to the combination of work and capital.

84.4.3 We Should Speed up the Innovation of Culture and Build the Innovation-Oriented Corporate Culture

The support of corporate culture innovation is important for the innovative enterprises to build sustainable competitive advantage and achieve innovation and development. The corporate culture innovation is the soul and power source for the innovation and development. The implementation of the innovation strategy of corporate culture can enhance the internal cohesion, centripetal force, the impact of external market can expand and enhance corporate image and improve their core competitiveness. Innovative enterprises to strengthen the building of enterprise culture, enterprise adhere to the path of continuous innovation an important guarantee. We should introduce advanced and successful concepts and methods into the enterprise to speed up the corporate culture innovation, to enhance the level of corporate culture, at a higher level and create a culture of independent innovation, enterprise culture and enterprise development to better support each other to form more dynamic, more creative enterprise workers unite vigorous spirit of enterprise, optimizing internal and external environment for enterprises bigger and stronger. The enterprises must work into the corporate culture of enterprise development planning and overall business development strategy, integrate into all aspects of enterprise innovation and development, enhance the independent innovation capacity, and promote innovation and enterprise culture.

84.4.4 We Should Understand the External Environment and Coordinate with the Environment Harmoniously

The external environment for enterprises includes industry conditions, market conditions and national environment and so on. In recent China, the domestic innovative companies are facing the domestic market and the gradual integration of the international market environment. There are both opportunities and challenges for the development of innovative enterprises. On the one hand, with the unification of the global market, the gradual reduction of trade barriers, foreign advanced technologies and techniques can also be the introduction of more domestic companies will help domestic enterprises to introduce innovative, digestion, absorption and re-innovation. On the other hand, some multinational companies have gradually developed into the Chinese market. They compete for market share with domestic enterprises and constitute a greater threat to domestic enterprises (Glimstedt et al. 2006). It provides a good political environment, and is a good opportunity for the development of innovative enterprises. This requires innovative domestic companies are facing a correct understanding of the environment, seize opportunities and meet challenges. Innovative companies must have keen market sensitivity, changes in the market environment to make a positive response, coordination of R&D and market environment changes in procedures, work close to the market, close to the customer, so that products can effectively enter the market, access to income.

84.4.5 We Should Implement the Development Strategy for Innovative Human Resources

The implementation of innovative human resources strategy focuses on the innovative capacity of a large number of innovative entrepreneurs talents. The Innovative entrepreneurs with special qualities and abilities of the creative talent, innovation and business continuity management depends on effective and innovative entrepreneurs, creative thinking, innovative ideas and dauntless courage dare to take risks (Paolo and Valentina 2005). Enhance the independent innovation capacity, accelerating innovative companies create a large number of construction is imperative that innovative spirit and ability with innovative entrepreneurs. Implementation of innovative human resources strategy, we must increase the scientific and technological human resources development, and strive together to create a recruitment, training, use only the good environment, the formation of personnel training, the introduction, the use of sound operational mechanism, creating a sufficient quantity, quality, structure reasonably high level of innovative technology personnel for access to scientific and competitive advantage, enhance independent innovation capability to provide personnel protection. Implementation of innovative human resources strategy, we must attach importance to high-level technological innovation to build their full potential, room to grow and create good high-level talent with the international and domestic academic exchanges and scientific cooperation platform. Implementation of innovative human resources strategy, we must strengthen the creative talents of the incentive and restraint mechanisms, establishing a system conducive to creative talents come to the fore. Through the establishment and strengthening of incentive and restriction mechanism, fully embodies the respect for knowledge creation, respect for human values, to fully mobilize the best talent of entrepreneurs and high-level initiative to stimulate their creative potential, promote innovation and personnel training, which can make more and more innovative talents standing out.

84.5 Conclusion

As the knowledge economy and the economic and scientific accelerating process of global integration, innovation has become the inexhaustible motive force and a key factor for socio-economic development and competitiveness of a country. At the same time, innovation also has become a deciding force and source for the survival and development of an enterprise. It is the key for enterprises to get advantage in the increasingly fierce competition. The innovative companies must vigorously promote independent innovation capability as their most urgent and core strategic task, take effective measures to master the core technologies with independent intellectual property, key technology, strengthen and enhance the original innovation, integrated innovation and the introduction of digestion absorption and innovation, and constantly enhance their core competitiveness (Chaohui and Qinghua 2008). Currently, the focus on independent innovation and building innovation-oriented country has become our national strategy and the transformation of economic growth and enhance the central part of national competitiveness. The key to achieving this strategic objective is to enhance innovation in enterprises in the dominant position, the establishment of enterprises as the main market-oriented innovation system combining production and research to enhance the capability of independent innovation of enterprises, and encourage a large number of innovative enterprises.

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Chapter 85
Construction of Organization Coordination Network of Major Scientific and Technological Projects

Xin-wen He, Ye Wang and Guang-ming Hou

Abstract Major scientific and technological project need many organizations to implement. In this paper, in order to deeply analyze the problem of organization coordination of major scientific and technological project, we use methods of systems engineering and project management, based on organization theory, coordination theory and network organization theory. We design three network models, including centralized network, adaptive network, distributed network, and discuss the process of management in organization coordination network of major scientific and technological projects. Finally, we analyze some characteristics of organization coordination network of major scientific and technological projects.

Keywords Major scientific and technological projects · Organization management mode · Organization coordination network

85.1 Introduction

Major scientific and technological projects need many organizations to implement. In order to achieve stated objectives, these organizations, under the guidance of the government, put the task coordination, product ordination and technology ordination together to form a complex and ordered network based on certain way linked, that is organization coordination network (OCN) of major scientific and

X. He (✉)
School of Management, Minzu University of China, Beijing, China
e-mail: 10808040@bit.edu.cn

Y. Wang
Business School, Central South University, Changsha, China

G. Hou
School of Management and Economy, Beijing Institute of Technology, Beijing, China

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technological project (MSTP). In this paper, for the reality of complex OCN, with the actual situation and needs of the organization management of MSTP in China, we use methods of systems engineering and project management, based on organization theory, coordination theory and network organization theory. We propose theoretical level organization coordination of MSTP. We design corresponding network model, which is significant for organization management of MSTP.

85.2 Organization Coordination Network Models

85.2.1 Construction Methods of Organization Coordination Network Based on Task (Product)

According to coordination theory and network organization theory (Haken 1981; Powell 1990), we use system decomposition integration and work breakdown structure technology, based on the methods of systems engineering and project management (Chai 2007; Qian 2007). According to the organization management practices of domestic and international MSTP, focused on its objectives achieving, we construct the OCN of MSTP based on task. The immediate objective of MSTP is developing products that can meet certain pre-established goal and property. The product is very complex, including many components, which requires much research to test whether it is successful. The work assignments are very large.

In the system engineering method, the extremely complex MSTP is known as "system", that is an organic whole with specific functions combined with several components of interaction and interdependence. And this "system" itself is subordinate to a larger system (Wang 2009; Project Management Institute et al. 2005). For example, missile weapon system is one of the most complex development systems of modern MSTP. It relies on thousands of people working together to develop the result (Qian 2007). Hsue-Shen TSIEN believes that developing such a complex system faces the question: "How to turn the general requirement of initial developing into specific work tasks of thousands of participants gradually. And how to integrate these tasks into an actual system of technically sound, economically viable, short development cycle and coordination operation. And also make it effectively subordinating a larger system." Describing the problem in this way he intends to prompt that system view which should be used to analysis questions, while solution of solving problems is system project method. System project commonly uses the way of "V" type figure to describe the scope and the basic method of system project working. It emphasizes the demand driven. First we disintegrate and define top-down from the system, subsystem to components. Then we integrate and test bottom up from components, subsystem to system. Finally, we get an overall performance optimization to meet the full life cycle requirement system. It can be seen that the system gradual decomposition and comprehensive integration is just the method core of constructing OCN of MSTP (Miles and Snow 1992; Li 2003).

Among project management methods, Work Breakdown Structure (WBS) targeted to deliverables should get a hierarchical structure after the implementation of work breakdown of the project teamwork aiming to achieve project objectives and create the necessary deliverables (Powell 1990). WBS determines the scope of the project and organizes them together orderly. WBS divides the project work into a number of small and manageable tasks, each dropping meaning more detailed description of the project work. In order to identify all the tasks of completing project work, WBS (and vocabulary) should divide the project needed completing according to deliverables structure of project, life cycle phase of project or use, into unit of work that is relatively independent, content single and easy to manage. In the US, according to management standards, any large products should establish WBS system and work out WBS dictionary, as the contact text to unified management framework of the ordering party and the contractor. It can be seen that WBS is the technology base of OCN of MSTP (Hong and Ke 2004).

Whether the system engineering "V" chart or the project management WBS, they mainly describe the whole tasks focused on product development. And each of them is a hierarchical tree structure chart based on breakdown of products, as shown in Fig. 85.1. Each level of product breakdown structure diagram respectively represents system, partial system, subsystem, components and other development tasks. Focused on the need to manage product development a production tasks services to ensure the achievement, including integration and assembly, test and evaluation, data management and personal training, assurance facilities and equipment and so on (Guo 2003). For different systems, the content of product development task breakdown structure is different, but the form is parallel. And the part of management security is commonly used. Both the tasks of whole system design breakdown integration and management security and the tasks of each sub-item (often referred as work breakdown or work package) after breakdown require one specific unit (project team) in the organization of separate implementation to undertake. Link relationship among tasks determines the link of the collaborative of several specific units within the implementing organization,

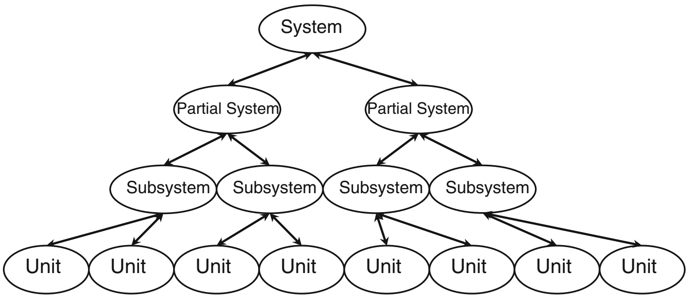


Fig. 85.1 Simplified task decomposition structure model of system

creating functional, project-based and matrix organization structure models that can reflect the relationship between project organization and functional department within implementing organization. Besides, it also determines the link relationship among a large number of implementing organization, creating the basic structure models of OCN of MSTP based on the whole WBS charter.

85.2.2 Model Construction of Organization Coordination Network

Just as a MSTP does not only have one feasible WBS charter, the OCN of MSTP also has several structure models, which depends on the hierarchical tree model of WBS. And it is also affected by how many tasks taken on by implementing organization, namely affected by the number proportion of implementing organization of different tasks taken on by different task hierarchy, and it is also fundamentally constrained by the economic institutional environment of MSTP. The basic models of WBS can ensure that one task is only taken by one implementing organization and one implementing organization can take on several tasks. Under this assumption, we will undertake the implementing organization computing of different tasks across task-level to calculation according to the implementing of the last task-level. We consider several factors including the basic model of the WBS, task level, task number, implementing organization number of the same task-level, implementing organization proportion of different task-level and economic environment. We list three typical representative distribution of different tasks and basic models of OCN of MSTP under different economic system as follows:

Centralized network. MSTP is integrated by whole systems decomposition. Partial system and subsystem development task are undertaken by a number of special units of a implementing organization (referred to system organizations). A small number of the bottom part development task is undertaken by other implementing organization (referred to component organization). MSTP is star shaped centralization structure model which regarded system organization as the core and component organization as the edge, Fig. 85.2.

Adaptive network. The whole system decomposition integration task of MSTP is undertaken by an implementing organization (referred to whole system organization).Partial system development task is undertaken by a large number of implementing organization (referred to partial system). A large number of subsystem development task is undertaken by few implementing organization (referred to subsystem organization). Numerous of bottom part development task is undertaken by lots of implementing organization (referred to component system). Thus, the OCN of MSTP manifests as adaptive structure model of level shape, Fig. 85.3.

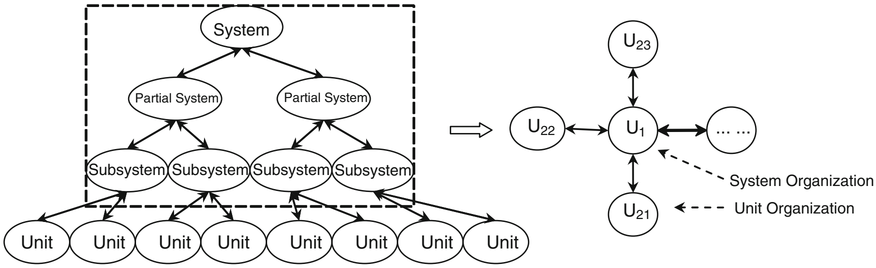


Fig. 85.2 The simplified centralized model of OCN of MSTP

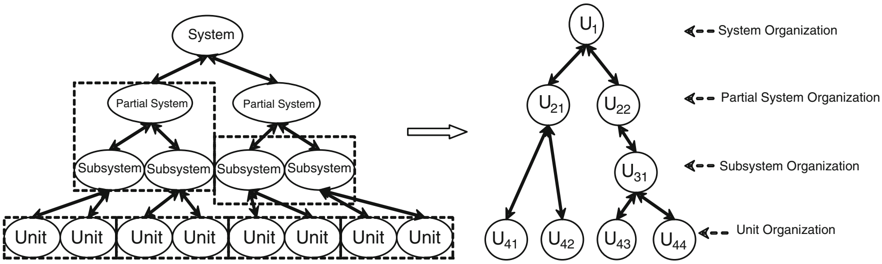


Fig. 85.3 The adaptive model of OCN of MSTP

Distributed network. The whole system decomposition integration task of MSTP is undertaken by a implementing organization. Every partial system development task is undertaken by each professional implementing organization. Each subsystem development task is also undertaken by special implementing organization. A large number of component development task is undertaken by professional implementing organization. Then the OCN of MSTP manifest as distributed structure model of level shape, Fig. 85.4.

OCN models of MSTP mainly include the above mentioned network models like centralized network, adaptive network and distributed network. If the number of implementary organizations, which have many task-levels and undertake different work assignments in every task-level, is equal, the OCNs of MSTP may show a chain-type structure. Among varieties of open OCN models of MSTP, the independent implementary organization can not only undertake different work assignments in the same task-level, it can also take on tasks in different task-levels (it would be better to decrease the number of the organizations which take on work assignment across multiple task-levels, or else the developed semi-finished products would turnover frequently and repeatedly among the implementary organizations and the cost and time would increase). Between different organizations, there are not only formal collaborative chained relationships, but also the informal ones that do not aim at the MSTP. Between the various implementary organizations, the target flow, task flow, labor flow, product flow, capital flow, technology flow, time flow and information flow will move vertically and horizontally.

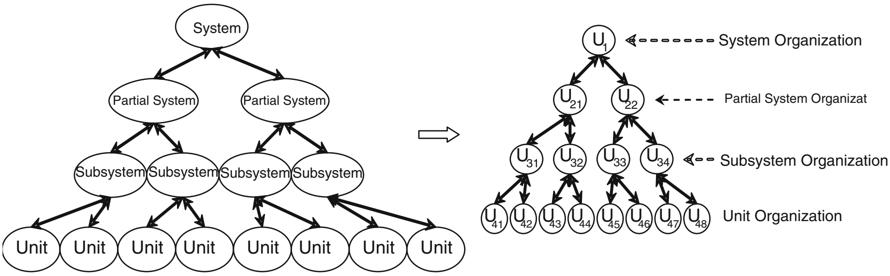


Fig. 85.4 The distributed model of OCN of MSTP

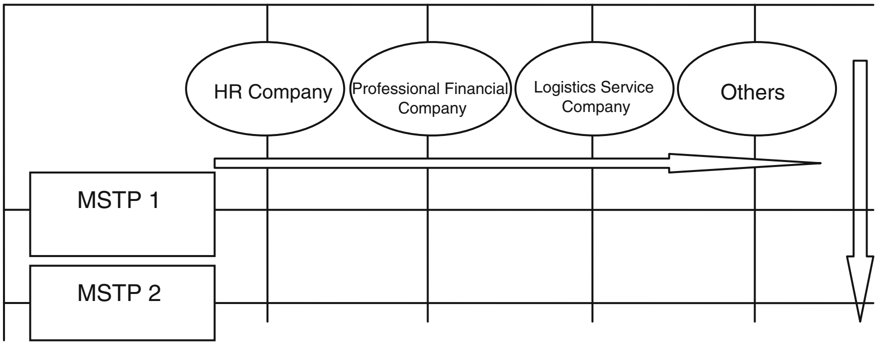


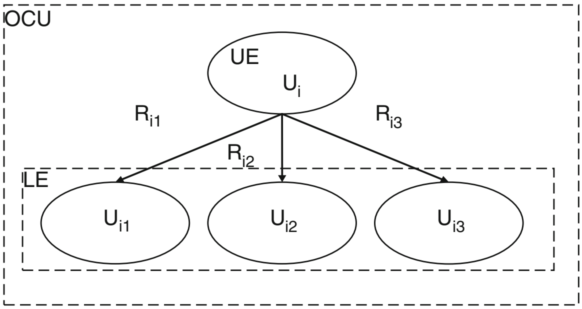
Fig. 85.5 Matrix structure of organization cluster

In addition, sometimes, several MSTPs are put into effect simultaneously and a large number of implementary organizations outsource the common management services security business to professional service organizations or companies partly. In the above conditions, organization cluster shows a very complex matrix structure. The brief model is shown in Fig. 85.5. This paper analyzes the problem of organization coordination of single MSTP. Between the organizations by which several MSTPs are carried out at the same time, there is no complete continuous coordinated relationship. So, the corresponding matrix structure is not within the scope of this study.

85.2.3 The Formal Quantitative Description of Organization Coordination Network Model

Whether centralized network, adaptive network, or distributed network, corresponding to levels type system task of MSTP, between a level of implementer organization and the next level, there is a monitoring and coordinated relationship.

Fig. 85.6 Basic structure unit diagram of OCN of MSTP



This relationship can finally be abstracted and shown in Fig. 85.6 which indicates the basic structure. Thus, it realizes the OCN structure of unified modeling. The OCN structure of MSTP is defined uniformly and formally as follows:

$OCU{::} = (UE, LE, CR)$
$UE{::} = U_i,\ i \in \{1, 2, \ldots, e\}$
$LE{::} = \{L_i \mid i \in \{1, 2, \ldots, e_1\}\}$
$L_i{::} = U_j,\ i \in \{1, 2, \ldots, e_1\},\ j \in \{1, 2, \ldots, e\}$
$CR{::} = \{R_i \mid R_i{:}\ UE \to L_i,\ i \in \{1, 2, \ldots, e_1\}\}$
$U_i{::} = E_i \mid Di,\ i \in \{1, 2, \ldots, e\}$
$D_i{::} = \{Ld \mid Ld \in L_j,\ j \in \{1, 2, \ldots, e_1\}\},\ i \in \{1, 2, \ldots, e\}$

In the above equation, OCU is the double-level basic structure set of OCN. UE is the upper implementary organization of the basic structure set. LE is the lower implementary organization of the basic structure set. CR reflects the relationship between the two levels of the implementary organization. E_i ($i = 0, 1, \ldots, e$) means the implementary organization. D_i ($i = 0, 1, \ldots, e$)is the leadership decision-making group. U_i ($i = 0, 1, \ldots, e$) refers to the relatively independent implementary organization. Ld means the main decision people who are chosen from the lower implementary organization. e refers to the total number of the implement organization in the network. e_1 is the total number of the lower implement organization in the OCU.

After the uniform and formal definition of the OCN structure of MSTP, we can build the tree structure of the OCN (in order to standardize, according to the principles, we split the mesh structure form into a tree shape structure form) shown in Fig. 85.7, the formal description of the quantitative is as follows:

$OCN{::} = (UE, LE, CR)$
$UE{::} = U$
$LE{::} = \{L\}$
$L{::} = E \mid OCN$
$CR{::} = \{R \mid R{:}\ UE \to L\}$
$U{::} = E \mid D$
$D{::} = \{Ld \mid Ld \in L\}$

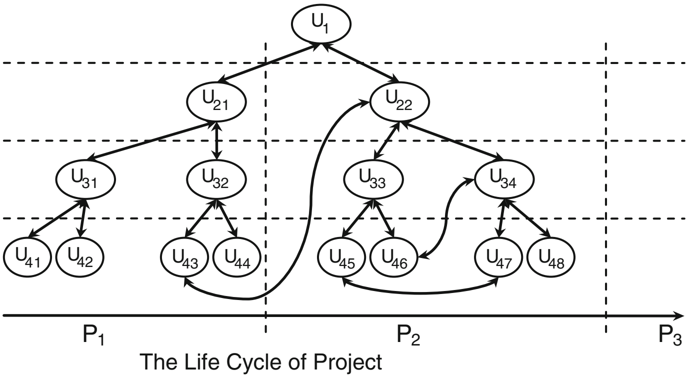


Fig. 85.7 Structure diagram of OCN of MSTP

Among the above equation, OCN is the built the OCN structure. Other definitions are as above. Thus, according to the above method, we can use these two kinds of basic structure form to construct other OCN model recursively.

85.3 The Characteristics of Organization Coordination Network

Systematicness: One of the features of system is the synergy of the subsystems, so that the overall effect is greater than the sum of the various subsystems. System approach is to determine and achieve the optimal target on the basis of analyzing the data, information and objective facts. Through system design and planning, to achieve identified goals, we should form a complete solution which includes the measures, steps and resources. During the program implementation process, the system management can improve the effectiveness. An organization coordination network of MSTP is a collaborative system. Interrelated processes will be confirmed as a system to understand and manage. It may help improve management efficiency and achieve the goal of the project.

Coordination: Major scientific and technological project itself is a system. Each implementation process and different management process is also a system. In the actual management process, we should analyze the relationship between the work links overall and should balance the various stakeholder interests adequately. We had better give full consideration to the synergies between various departments and implementary organizations, so that Major scientific and technological project can develop orderly, coordinately and efficiently.

Motivation: Implementary organization is the key node of organization coordination network of MSTP. The effective management about organization coordination network of MSTP requires not only the highest organizers of the correct orientation, but also depends on the whole implementary organization's active participation. So, to deal with implementary organization, we should take effective incentives to stimulate the enthusiasm and social responsibility of it. We need to focus on the strong professional disciplines constitute of implementary organization. Besides, we had better enhance the spiritual and cultural refinement of MSTP. We should enhance the enthusiasm and initiative of each implementary organization so that the organization's energy can play out fully and we can promote organization coordination network's overall development.

Efficiency: There are many evaluation standards about organization coordination network of MSTP. But the main standard should be performance. If we want to build organization coordination network of MSTP, we must improve the efficiency. Besides, we may systematically analyses and research various factors that affect the development of organization coordination network of MSTP. Through taking effective measures and methods, we mobilize departments and implementary organization's enthusiasm in many ways. By the strict and effective construction of organization coordination network of MSTP, we ensure the cooperation between the implementary organizations so that the MSTP can be carried on orderly and efficiently. We should improve the efficiency of organization coordination network of MSTP and finally realize the goals of MSTP.

85.4 Conclusion

OCN are key elements of organization and management of MSTP. Combined with the organization and management practice, based on coordination theory and network organization theory, we use methods of systems engineering and project management. We propose some principles to construct OCN of MSTP, which are the same objectives, division of labor, information communication and streamlining the upper. We design three network models, including centralized network, adaptive network, distributed network. Among them, the task-based distributed network shows network structure which is characterized by hierarchy and tree type and it reflects the typical cross-organizational coordination rules. OCN of MSTP has four characteristics: systematicness, coordination, motivation and efficiency. It has complex entity elements, inter-entity relationships, network structure and management operation mode. So, it requires an in-depth systematic research.

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Chapter 86
Research on Factors Composition Model of Independent Innovation Capability for High-Tech Enterprises Based on Factor Analysis

Xiang-dong Li, Shu-qiang Wang, Ling Ma, Shu-cheng Luo and Shuo Wang

Abstract With the time gradually reduced of high-tech enterprises turning research results into productive, the factors composition problem of independent innovation capability for high-tech enterprises are get more and more attention. From the point of enterprises' innovation activities and innovation methods application, twelve concept generics were established through study on existing achievements and business interviews. Measurement items of the twelve concept generics were put forward by content validity analysis and project analysis. Via using questionnaires to collect sampling data, the construction validity and internal consistency reliability of the questionnaires were inspected. Through applying the factor analysis method, the factors composition problem of independent innovation capability for high-tech enterprises was analyzed. The factors composition model of independent innovation capability for high-tech enterprises was established.

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X. Li (✉) · S. Wang · L. Ma · S. Luo
School of Economics and Management, Hebei University of Technology, Tianjin, China
e-mail: lee96xd@163.com

S. Wang
e-mail: wsqxaf@126.com

L. Ma
e-mail: maling79@163.com

S. Luo
e-mail: lsc@hebut.edu.cn

S. Wang
Economic and Management Department, Nankai University Binhai College, Tianjin, China
e-mail: tarzen4@hotmail.com

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Keywords Composition · Factor analysis · High-tech enterprises · Independent innovation capability

86.1 Introduction

In today's world, biological and medical technology, electronic and information technologies, new materials and advanced manufacturing technology achieved an unprecedented development. Scientific and technological progress and innovation is a decisive force for social development. The independent innovation capability in enhancing national competitiveness, promote economic development, improve enterprise efficiency plays an increasingly important role.

At present, the research to the independent innovation ability at home and abroad is mainly from the perspective of innovation process, innovation systems and creative behavior. The study on the capability factors composition model based on the innovation process gains certain dominance. Andergassen and Nardini proposed that innovation capability was the common result of the new product research and development capabilities, technical improvement capabilities, reserve capabilities and organizational abilities (Andergassen and Nardini 2005). Some scholars believe that nature of independent innovation is technology innovation, which is achieved through acquiring technology development control powers and autonomous powers.

Alder and Burgelman give the composition of technological innovation capacity (Adier and Shenbar 1990; Frohman 1999). Wang and Feng (2008) put forward that the independent innovation capability of enterprises included potential resource of technological innovation, technological innovation activities, technological innovation output capacity, and technology innovation environment. Huang et al. (2009) concluded the six critical dimension of the independent innovation capability from the perspective of enterprises' innovation subject and the innovation process. Yuan and Wang (2010) considered that it included innovative resource input capability, innovative resource allocation capability, and output capacity of innovation achievements. Hao (2011) brought out that it included technical capacity and network capacity. Wan and Li (2008) thought that it included input capability of independent innovation, output capability of independent innovation, running ability of independent innovation, and independent innovation environment support capability. Huang and Liu (2010) divided the independent innovation capability into three levels, including innovation core competence, innovation key competencies, and innovation base ability. Zhang et al. (2007) thought that it included factor inputs ability of independent innovation, research and development ability, innovation production capacity, new products marketing capabilities, and innovation management ability. Gao et al. (2010) divided it into the ability to select, research and development ability, integration capabilities, and learning ability from the perspective of knowledge integrated management. Existing research on understanding of the innovation process relatively close, but innovation process standards are not consistent, so many experts propose a variety of innovative process models (Chiesa et al. 1996; Stevens and Berley 2003; Chen 2005; Yuan et al. 1994). This makes study results based on independent innovation capability of the innovation process can be accumulated in less. Existing results is mainly to research from a perspective of qualitative. Lacking of the collection of samples based on adequate theories, to establish model and undertake statistical analysis.

Through the analysis of existing research on independent innovation capability, innovation capability reflects not only on the creative output and behavior, more potential for innovation. Innovation potential is also reflected in the innovation processes of all kinds of creative activities, and innovation methods have a significant impact to the innovation potential and innovation activities. Compared with traditional technologies, high-tech has "seven high", "seven new" feature. They are high investment, high yield, high intelligence, high difficulty, high competition, high risk, high potential energy, new knowledge, new technology, new methods, and new technology, new equipment, new material and new product. Innovation methods for technology and institutional innovation capability of high-tech enterprise have an obvious role. In this paper, authors argue that it is more suitable for researching on the factors composition of the independent innovation capability for high-tech enterprises from the perspective of innovation processes and innovation methods.

86.2 Content Analysis and Test Items of Independent Innovation Capability

86.2.1 Encoding Results of the Interview Content

In order to effectively collect independent innovation information about the high-tech enterprises, Semi-structured interviews was used. Combined with the interview process, we collected relevant information, carried out content analysis and refinement.

Based on study of the independent innovation capability, we focused on two aspects taking into account the independent innovation capability. One hand is innovation activities capability innovation process-oriented, on the other hand is innovation method supporting capability.

According to the interview data, combined with the analysis of the domestic and foreign research results about the capability of independent innovation, we selected two PhD students and three Masters of management science of management to encode and analyze the interview data of the enterprises. Considering the relevance of the content and information in general, twelve concept generic formed initially is as follows: future foreseeing capability, scientific thinking capability, requirement elicitation capability, management customer relationship capability, technology forecasting capability, concept formation capability, R&D and design capability, manufacturing capability, sales income capability, assumption recognition capability, scientific method master capability, and scientific tool application capability.

86.2.2 Measurement Items of the Independent Innovation Capability

According to the twelve concept generics, measurement items of factors composition of independent innovation capability were designed on the basis of the theoretical analysis, interviews and existed scales.

The measurement items of future foreseeing capability are as follows: entrepreneur can be able to withstand intense pressure, and take risks and explore during the management predicament (FF1); enterprise can timely perceive external threats (FF2); enterprises seek proactively favorable development opportunities, identify risks, and compete for greater development (FF3); enterprise can seek initiatively the opportunity available to it (FF3); enterprise can do its best to capture the technology fitting the market demand, and to recommend new brand, new product, new business (FF4); enterprise can identify the market opportunity, exploit it, initiatively response to it and then put into effect (FF5); enterprise has abundant society net resource (FF6); enterprise can integrate the information from many channels to forecast the technology development and set it into the strategy (FF7).

The measurement items of scientific thinking capability are as follows: enterprise spend shorter time than its competitor on conceiving the new project (ST1); enterprise does its best to cultivate the scientific consciousness of its employees and the knowledge is shared and exchanged fully between its employees (ST2); R&D personnel have original creation and grasp the professional knowledge of the innovation (ST3); enterprise can choose exact innovation orientation and correct innovation route (ST4).

The measurement items of requirement elicitation capability are as follows: enterprise deeply comprehend the demand of the consumers (DF1); demand information can be set in new product development in time and effectively (DF2); enterprise inclines to spend many resources on the research on the market and demand (DF3).

The measurement items of management customer relationship capability are as follows: enterprise is capable of market survey, grasp the market feedback information, and can deeply study the demand of the clients (CR1); enterprise can do its best to popularize the product and service and advance the fame of the brand to be accepted by the society broadly (CR2); enterprise usually collect market information and make the marketing scheme to recommend the new product

(CR3); marketing personnel is capable of developing the potential clients and maintaining the existing clients (CR4); after-sale service is in high level (CR5).

The measurement items of technology forecasting capability are as follows: enterprise can penetrate exactly the development of the technology, and trace the newly information of the technology development (TF1); enterprise regards to work out the strategy plan which is used to guide the important technology decsion(TF2).

The measurement items of concept formation capability are as follows: enterprise can use effectively the inside and outside resources, for example patent and technology secret and so on (CF1); enterprise would like to spend much resource and long time to make feasibility analysis on market demand, technology and finance of new product concept (CF2); enterprise can deal with and integrate information (CF3); enterprise can recommend rapidly the new product and service (CF4); enterprise can evaluate rapidly the feasibility of the new product in market, technology, and finance (CF5).

The measurement items of R&D and design capability are as follows: enterprise has R&D and design function branch, and is capable of digesting and absorbing the new technology (RD1); the plan and object of developing the new project is clear (RD2); all branches can cooperate closely to run the new project (RD3); enterprise has perfect development and operations system of the new project (RD4); schedule, cost and quality of the new project can be control to the scheduled level (RD5); enterprise can develop independently the new product with good prospect (RD6).

The measurement items of manufacturing capability are as follows: quality control system is perfect and effective (MC1); technical level and working efficiency of personnel is high (MC2); income-producing equipment is advanced, and manufacturing cost is enough low (MC3); enterprise usually initiatively introduce the advanced technology improving the process (MC4); flexibility of the producing system is enough to satisfy the special demand of the clients (MC5).

The measurement items of sales income capability are as follows: enterprise has enough experience and capacity to recommend the new product and put it in the market (SI1); marketing channel is widespread and efficient (SI2); marketing sales net is perfect (SI3); product and service satisfy the clients very well (SI4); enterprise can use fully E-commerce to sell (SI5).

The measurement items of assumption recognition capability are as follows: product is changed frequently (IR1); top level of the enterprise is inclined to recommend the new idea and product, and the innvation scheme is drafted out perfectly (IR2); enterprise has the atmosphere of regarding talent and encouraging the innovation thinking (IR3); enterprise regards that the decision made by the enterprise should fit the market change (IR4); enterprise can evaluate product originality (IR5); enterprise assigns the given personnel to collect, keep and answer the new idea (IR6).

The measurement items of scientific method master capability are as follows: enterprise can apply all kinds of technology and knowledge for new project development (SM1); enterprise takes the train heavily and provides the personals good train and sets up stable train scheme (SM2); The amount of patent application raise stably (SM3); enterprise can make use of other organization to provide the R&D engineers the innovation method train (SM4).

The measurement items of scientific tool application capability are as follows: train to personnel is practical and effective, and technology and management difficulty can be solved more and more perfectly (STA1); computer assistant innovation system can be used substantially in the course of developing the project (STA2); information-based communication is carried out fully (STA3); enterprise can integrate several kinds of innovation method and instrument, and search for and improve the innovation method applying system (STA4).

86.3 Factor Analysis of the Factors Composition of Independent Innovation Capability

86.3.1 Content Validity Analysis

Content validity means how much degree of the measuring points reflecting the conception. Qualitative and quantitative method can all be used in measurement research. In the paper, quantitative method was used to test the match degree between the items and the definition of each concept generic. Firstly, 30 valuators were selected including 12 domain experts, 5 doctoral candidates and 12 master's candidates. Then, the concept generics' definition and the measurement items were given to them, and they need to distribute each item to the reflecting concept generic. Finally, according to the evaluation results of 30 valuators, the scores of each item in each concept generic were calculated. The item was proved to reflect the concept generic if the score was above 0.6. The score formula of each item in the concept generic is as follows:

$$S_j = \sum_{i=1}^{n} x_i / 5n \tag{86.1}$$

Among the formula: "S_j" is the score of the item of number "j" in each concept generic. "x_i" is the evaluation result given by the valuators "n" is the number of the valuators.

Through score calculation of the evaluation results, the items of FF1, FF2, FF6, DF1, CF4, CF5, RD6, IR1, IR3, IR4, SM2, and STA3 were deleted because the score of them was below 0.6, and the other items were reserved. Meanwhile, according to the valuators' suggestions, the items of TF3 and CF6 were added. TF3 was added to technology forecasting capability, which means "the technical route can be used to support the business strategy and for technical orientation". CF6 was added to concept formation capability, which means "the possessed quantity of patents were above average level of the same industry".

86.3.2 Item Analysis

Item analysis is used to calculate the critical ratio (CR) of each item in the questionnaire. In the paper, 27 % samples having higher scores were divided into the higher score group, and 27 % having lower scores were divided into the lower score group. After content validity analysis, the questionnaire was designed by Likert scale of 5 points. The questionnaire was provided to 20 companies which we had interviewed. 360 cents of questionnaire were sent out and 323 cents taken back (the collecting rate is 89.7 %). After selection of the 323 cents of questionnaire, we got the valid questionnaire 261 cents (the valid rate is 80.8 %). Then item analysis was done with the valid questionnaire by SPSS20.

According to the critical ratio of each item, 6 items didn't reach the significant level. They are FF3, CR1, CR4, RD1, SI3 and SI5. So those items were deleted and the other items reserved. Through project analysis, 40 items were remained in the questionnaire, and each had higher identification degree.

86.3.3 Factor Analysis

Factor analysis can be used to test the construction validity of independent innovation capability. Meanwhile, it is a kind of method to analyze the potential construction. We can use it to transform the corresponding variables of independent innovation capability to several factors. Each factor has conceptualization significance and be independent to each other. To test the construction validity and internal consistency reliability, the data of 261 questionnaires will be taken to do factor analysis by SPSS20. Then the components model of independent innovation capability for High-tech enterprises will be established.

Before factor analysis, Kaiser–Meyer–Olkin (KMO) measure of sampling adequacy and Bartlett's sphericity test was done. The results showed that: KMO is 0.858, which is above 0.5; and the significant coefficient is 0.000, which is below 0.01. Then the scale was concluded to be suitable for factor analysis.

Through factor analysis at the first time, we found the extraction value of each item was above 0.4. We got 8 factors whose Eigen value greater than 1, and the total rate of variation interpretation was 82.691 %. Through further analysis, it was found that: (1) cross load existed in some item; (2) the number of items was small in some factors; (3) some item s aggregated in the same factor, but the content meaning had large difference. For example, the eighth factor included only one item that the load coefficient higher than 0.4, but lower than 0.5. Therefore, the items should be adjusted or deleted. Through several times of exploration, 15 item s were deleted as FF5, ST2, ST3, DF3, TF2, TF3, CF2, CF3, RD3, RD4, MC1, SI1, SI4, STA1, CR2. Then 25 items were remained for further analysis.

Table 86.1 The internal consistency reliability of each factor and the whole scale (N = 261)

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	The whole scale
Cronbach's α	0.813	0.775	0.762	0.831	0.805	0.861

Through factor analysis at the second time, we found that KMO is 0.863 and the significant coefficient is 0.000. So we concluded that the questionnaire of 25 items was suitable for factor analysis.

Through analysis of internal consistency reliability for the remained 25 items, the Cronbach's α of each factor and the whole scale were all above 0.6. As shown in Table 86.1, the questionnaire of 25 items had good internal consistency reliability.

Finally, we got five factors by factor analysis, and the total rate of variation interpretation was 83.871 %, as shown in Table 86.2.

Table 86.2 The factor analysis results of independent innovation capability for high-tech enterprises (N = 261)

Item	1	2	3	4	5
Factor 1 innovative methods acquiring and application					
SM3	0.940	0.013	0.234	0.039	0.024
ST4	0.936	0.011	0.222	−0.002	0.013
STA4	0.925	0.012	0.215	0.005	0.045
SM4	0.902	0.062	0.156	0.031	0.010
SM1	0.867	0.080	0.159	0.016	0.050
STA2	0.792	0.132	0.276	0.075	0.033
ST1	0.723	0.098	0.233	0.084	0.164
Factor 2 transformation of innovation					
MC2	0.052	0.906	0.243	0.170	0.062
RD2	0.017	0.903	0.274	0.190	0.077
MC3	0.015	0.903	0.249	0.195	0.060
MC5	0.008	0.861	0.230	0.171	0.008
RD5	0.012	0.830	0.270	0.223	0.031
MC4	0.224	0.620	0.175	0.146	0.186
Factor 3 fuzzy front end innovation					
IR5	0.311	0.289	0.856	0.029	0.089
CF6	0.302	0.291	0.856	0.036	0.094
DF2	0.326	0.308	0.833	0.055	0.105
IR2	0.288	0.251	0.783	0.032	0.023
CF1	0.330	0.297	0.760	0.040	0.030
IR6	0.316	0.300	0.726	0.051	0.005
Factor 4 technical strategy innovation					
TF1	0.006	0.258	0.022	0.914	0.133
FF7	0.017	0.230	0.003	0.906	0.168
FF4	0.000	0.334	0.066	0.901	0.062
Factor 5 commercialization					

(continued)

Table 86.2 (continued)

Item	1	2	3	4	5
SI2	0.007	0.122	0.046	0.209	0.865
CR3	0.074	0.256	0.063	0.239	0.748
CR5	0.147	0.385	0.100	0.109	0.726
Rate of variation interpretation	38.819 %	23.258 %	11.745 %	5.689 %	4.360 %
Total rate of variation interpretation	83.871 %				

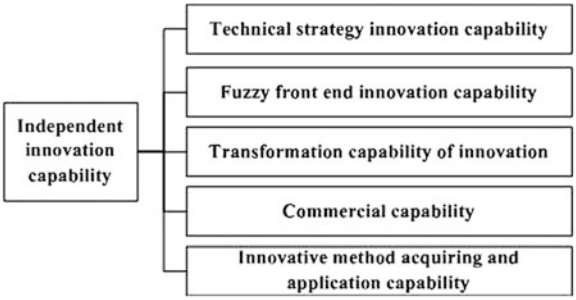

Fig. 86.1 Factors composition model of independent innovation capability for high-tech enterprises

According to the results of factor analysis, the independent innovation capability of high-tech enterprises was composed of five factors, named innovative methods' acquiring and application, transformation of innovation, fuzzy front end innovation, technical strategy innovation and commercial capability. The total rate of variation interpretation was 83.871 % without cross load. The load coefficient of each factor was all above 0.6. Therefore, the components model of independent innovation capability for High-tech enterprises was established, as shown in Fig. 86.1.

86.4 Conclusion

High-tech enterprises are important composition of national innovation system. The capability of independent innovation is closely correlated with the development of high-tech enterprise. So it is necessary to study the composition structure of independent innovation capability. Based on systematic analysis of present research results, enterprise interview process and problem was designed in detail. Then "Rolling Snowball" method is used to interview enterprises and collect research data in the paper. Through data coding by Nvivo8, 12 concept generic are formed including future foreseeing capability, scientific thinking capability, requirement elicitation capability, management customer relationship capability, technology forecasting capability, concept formation capability, R&D and design capability, manufacturing capability, sales income capability, assumption recognition capability, scientific method master capability and scientific tool application capability. On the basis, the measurement item of independent innovation capability is established by content validity analysis. According to project analysis of investigation results on high-tech enterprises, the items with higher identification degree remained. The valid questionnaire is used for factor analysis, after KMO and Bartlett's sphericity test. Then five factors of independent innovation capability for high-tech enterprises were obtained, which includes innovation methods acquiring and application, transformation of innovation, fuzzy front end innovation, technical strategy innovation and commercial capability. Therefore, the factors composition model of independent innovation capability for high-tech enterprises was established.

The independent innovation capability of high-tech enterprises is a comprehensive ability involving various complex factors. It is a set of strategy, assumption, research and development, design, manufacture, commercialization and method. This research aimed at the problem of independent innovation capability of high-tech enterprises, and considered their characteristics of "Seven High" and "Seven New". Therefore, the factors composition of independent innovation capability for high-tech enterprises was explored in the paper, from perspective of the role of technology in innovative activities and method support for innovation activities.

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Chapter 87
Research on Data Filtering Technology Based on the RFID Middleware in the Internet of Things

Kun Huang, Bing-wu Liu and Jun-tao Li

Abstract Middleware technology is becoming a hot topic in research due to its important position in the application of radio frequency identification (RFID). This paper first introduced the architecture of the Internet of Things, as well as the important position of the RFID middleware, and then summarizes the existing data filtering methods and characteristics of several filters. At last build the initial form of a combination of filters, take smart shelves for example.

Keywords RFID middleware · Internet of things · Data filtering · Smart shelves

87.1 Internet of Things

Internet of things, abbreviated as IOT, is a network which through radio frequency identification (RFID), infrared sensors, global positioning system, laser scanners and other information sensing device, make articles connect with internet to realize information exchange and communication according to the agreed agreement, in order to achieve intelligent identification, location, tracking, monitoring, and management. Internet of Things is "the Internet connects material objects". It has two meanings (Shen 2009): first, the core and foundation of the Internet of Things is still the Internet, it is the extension and expansion of the Internet network.

K. Huang (✉) · B. Liu
Graduate Division, Beijing Wuzi University, Beijing 101149, China
e-mail: huang__kun@126.com

B. Liu
e-mail: Liubingwu@bwu.edu.cn

J. Li
School of Information, Beijing Wuzi University, Beijing 101149, China
e-mail: Lijuntao@bwu.edu.cn

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Second, its client-side spread and extended to any goods and articles for information exchange and communication.

The application of the Internet of Things is bound to produce vast amounts of sensory data, how to collect, store and process this mass data in real time is a problem. In addition, a number of sensory devices are provided by different hardware vendors, and now China has not yet formed a uniform standard in interface and protocol-aware layer. How can complex equipment be seamlessly integrated into the existing system? How to carry out a unified monitoring and management for the sensory devices? How to seamlessly integrate new equipment into the Internet? These are big challenges to the development of Internet and which is the responsibility of the Internet of Things application middleware have to shoulder. In this paper the Internet of Things middleware mainly refers to the RFID middleware (Ding et al. 2006a).

87.2 RFID Middleware

RFID is the abbreviation for "radio frequency identification", which is a non-contact automatic identification and data collection technology (Qing and Li 2004). The application of RFID technology is expanding rapidly after the 1990s. From 2000 year to the present, RFID product range has been significantly enriched and costs is becoming lower and lower, a variety of new applications are emerging.

RFID System includes RFID hardware and application support software. Hardware part is made up of electronic tags and readers. Electronic tags are data carriers, which is divided into passive RFID label, half-passive RFID tags and active RFID tag. Passive electronic tag extracts the radio frequency energy radiate by the reader as its working power and transmits the label information to the reader; Semi-passive tags and active tags powered by battery. RFID middleware, known as the nerve center of the RFID systems (Huian 2004), is the most important part of the RFID software system, it directly face mass data collected by hardware, filter the data and submit to the high-level application software after effective packaging. Nowadays, research on RFID middleware is mainly concentrated on how to filter the vast amounts of data, the redundancy, and exploit the useful information (Ding et al. 2006b).The functions of RFID middle ware are shown as Fig. 87.1.

87.3 Data Filtering

The original data collected from the underlying hardware is enormous, yet truly meaningful to the user is not so much. If redundant data is not filtered out, it will bring three aspects of the burden:

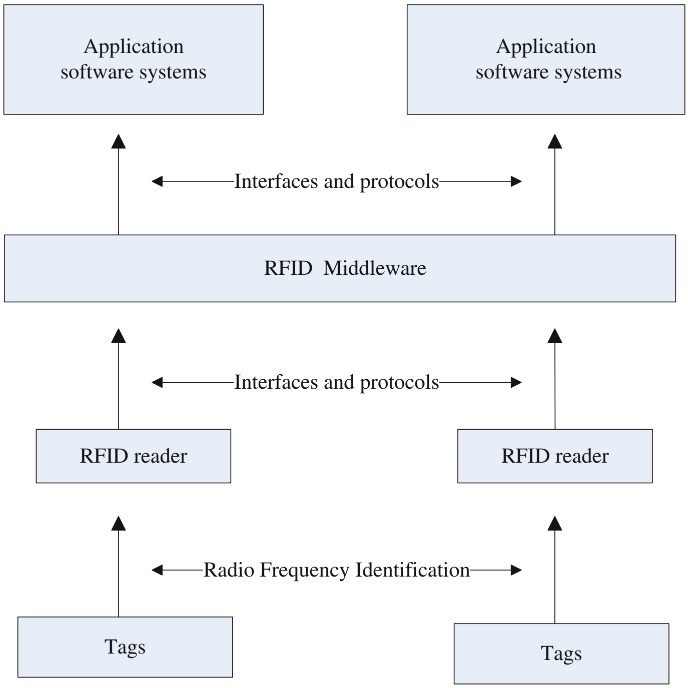

Fig. 87.1 RFID middleware diagram

1. Burden on network bandwidth due to the transfer of large amounts of data;
2. Burden on Data processor due to the needs of handling large amounts of data;
3. Burden on data storage due to the database need to store large extra amounts of data.

Middleware receive data from RFID reader, there will exist some redundant information and also wrong information. So it is necessary to filter the data, this is also its important feature, filter's purpose is to eliminate redundant data, eliminate "useless" information and transmit "useful" information application.

Redundant data that middleware needs to filter out including:

1. In a short term the same RFID readers duplicate reported the same data. When detecting node location, fixed node information duplicate reported; nodes are repeated tested when the node goes into and out of an area.
2. Neighboring readers report the same data. Readers have a missing rates, it has a relationship with the placement of the antenna, the distance from readers and the texture. Typically to ensure the read rates, there may place more than one reader in the same place. More than one reader report the monitored articles may generate repeated data.

3. In addition to the above issues, many users might also want to get some information for a particular node, the information for new node and disappeared node or just some special node.

When users use the data, what expected is minimized redundancy and gets accurate data close to the demands; it's up to middleware to solve this problem. Solution for redundant information is to set filters for processing in middleware. According to the requirements of different systems, it need to set different types of filters; according to some of the redundant data listed above, current filter can be summed up in the following three ways:

1. Weight filter

The data we collect often produce a significant amount of redundant data, filter can eliminate the redundant data (Jiang and Tan 2008).For filter, we adopt a filtering algorithm as follows: assumes that the data middleware acquired can be expressed as (*ReaderID*, *NodeID*, *Timestamp*), wherein *ReaderID* is the ID of RFID reader, *NodeID* identifying RFID node ID, *Timestamp* represents the node's read time. In the filtering process, the data will be put into a Hash table, use *NodeID* as hash table keys. We define a time interval, when the reader read a new node data, check if there are nodes with the same data in the Hash table. If there are nodes with the same data and the read time lag between the nodes is less than *Timelnterval*, then consider the node as a repeat reading data that should be filtered. Meanwhile update the node data's read time in the hash table. If there are nodes with the same data and the read time lag between the nodes is greater than *Timelnterval*, the node data is considered to be the new node data that need be output. Meanwhile update the node data's read time in the hash table. If it does not exist, then insert it into a Hash table and output the node data.

2. Event filter

In this paper, middleware mainly filter three kinds of nodes: new node, left node and currently active node. A new node means the node appears this time that never appear before. Left node is the node that has appeared several times before but does not occur in the *PersistTime*. Current active node represents a new node and the node appeared last time and occurs in the *PersistTime* once again.

For event filter (Li et al. 2006), we adopt a filtering algorithm as follows: assume that nodes data's format is (*ReaderID*, *NodeID*, *Timelnterval*). In the filtering process, put the currently active node data into a Hash tables, regard NodeID as Hash table key word. Set up another two queues, hold new node data and node data that have already left. When you are reading a node, checking whether the Hash table exist the same node, if it does not exist, then insert it into the Hash table and the new label queue. If it exists, then updates the node's reading time in the Hash table. Traverse the Hash tables, put the node that does not update in *PersistTime* into the queue of nodes that has already left, and then remove it (Zhao 2006).

3. Invalid RFID Data filter

In practical applications, data filters also have other requirements rather than data redundancy filtering. Due to instable signal or other interference factors, the RFID tags of items which are on the shelves can not be detected in each reader cycle; or when the customer pushed his cart next to shelf, merchandises within the cart be read by the readers in the shelf, this is invalid RFID data.

Identify the occasional data and erase it through program is the key to invalid RFID data suppression. Algorithm presented here uses a threshold (Alfonsi 2004), each label's report is given a certain amount of weight, reduce the weight of labels that do not appear. When the label value is be above or below the threshold, triggering the appropriate label (Palmer 2008). This algorithm is described as follows:

1. Defines the label's add up value after each appearance as *valueStep*;
2. Defines the threshold that triggers the tag's appearance as *fapp*;
3. Defines the threshold that triggers the tag's disappearance as *fdis*;
4. Defines the label status's field as *detectStatus*;
5. If the label appears, its weight adds *valueStep;*
6. If the label does not appear, its weight value will reduce 1;
7. Label weight value greater than or equal to *fapp*, *detectStatus* = *false*, the label appearance event is triggered, generate a label appear records and then reset *detectStatus* to *true*;
8. Label weight value less than or equal to *fdis*, *detectStatus* = *true*, the label disappearance event is triggered, generate a label disappear records, and reset *detectStatus* to *false*.

In the algorithm above the threshold can be set according to needs, because an invalid RFID data occurrences less, it is difficult to appear above *fapp* or below *fdis*, it can effectively inhibit invalid RFID data.

87.4 Further Analysis of the Data Filter

In specific application, in order to ensure the effectiveness of the information uploaded to the upper-layer service interfaces, the three type filters above are used in combination to improve the filters accuracy. Following part sets the intelligent shelf in supermarket which is popular in intelligent logistics system as an example to illustrate the combination of a smart filter. Figure 87.2 shows the filtering process of smart filter.

By smart shelves, administrator can monitor shelf articles in real time. First, when there is repeating entry of articles already exists on the shelf, weight filter eliminate redundant information. Second, administrators need to know when a new product put on the shelves or what merchandise is bought by customers, then event filter work. Third, when the articles customs get from another shelves passing the

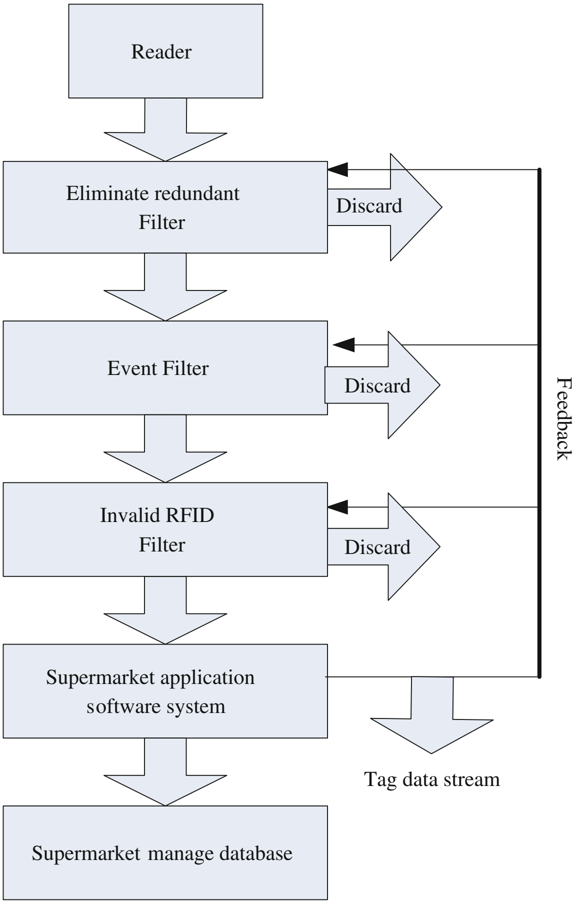

Fig. 87.2 Flow chart of data filtering

shelf, RFID reader may read this product information and regard this product as a new product, so an error occurs, invalid RFID filter has its place. Thus, RFID middleware use triple filter combination to filter out redundant information effectively before the label information be passed to upper-layer application software and reduce the burden on the system.

87.5 Conclusion

This paper study the basic knowledge of RFID middleware in the internet of things, points out the importance of RFID middleware in the internet of things. Through research on the different features of the existing filtering technology and the example of smart shelves, this paper discussed the availability of the combinations of filters. Hope this paper can contribute to the further development of data filtering technology based on the RFID middleware.

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Chapter 88
The Application of Panel Data Mining Based on Gene Schema in Predicting Finance Distress

Feng-ning Ma, Ji-ting Yang, Shi-qiang Jiang and Qin-yu Ren

Abstract Various different methods has been applied in the field of predicting finance distress, including statistical analysis, neural network technologies, genetic algorithm, logistic analysis etc. Although these classical methods have good performance in the prediction of financial distress, there still exist some other disadvantages. As financial data should be panel ones, most investigations only focus on one year's financial data to interpret the underlying statistic model, which hence may fail to characterize the business failure tendency of ST companies. In comparison, panel data combines cross-section data with time series data so that it can provide researcher with a huge amount of data as well as multi-dimension perspectives. By utilizing panel data based on the binary gene expressions, this article aims at constructing a dynamic prediction model which can explore multiple years' financial data. By resorting to the dynamic thresholding techniques, the marginal value during discretization can be properly derived by a relative floating on the corresponding industry average value. Relying on the discrete expression, the period gene can be identified from the provided time binary sequence, which can be then explored to recognize ST company. Numerical simulation has demonstrated that our new method can significantly improve the prediction accuracy of realistic financial data, which is of great significance to both theoretical analysis and realistic applications.

Keywords Panel data · Period gene schema · Financial distress

F. Ma · J. Yang (✉) · S. Jiang · Q. Ren
College of Management and Economics, Tianjin University, Tianjin, China
e-mail: sophia-yangji@163.com

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88.1 Introduction

During the last four decades, the issue of financial distress prediction has been extensively investigated, which has been evolved from the primary statistical methods to the more appealing intelligent techniques. Among the hot research topics, predicting corporate failure has long being remained as an important issue, since it affects the interested decision making including stockholders, creditors, senior management and auditors.

The icebreaking work on the prediction of financial failure was initialized by the U.S. Beaver in (1966), in which a simple univariate analysis was adopted. Then, in (1968) Altman employed a linear discriminant analysis based on the multivariable model to analyze the financial corporate failure of several companies. Lately, in (1980) Ohlson used the appealing logit model to identify the significant 9 statistic variables that have heavy impact on firm failures. In (1992), Tam and Kiange applied the back-propagation neural networks (BPNN) to fanatical failures prediction, and concluded that BPNN performed better than the other methods. From then on, an important trend has been emerged which build the sophisticated soft computing architectures or hybrid intelligent strategies to the problem analysis (Ravi Kumar and Ravi 2007). Sun and Li (2008) proposed a decision tree model combining attribute-oriented induction, information gain and decision tree for financial distress prediction. Kim and Kang (2010) put forward an ensemble with neural network in the bankruptcy prediction field, which has been proved more accuracy. du Jardin (2010) improved the prediction accuracy of neural network based model using a set of variables selected with a criterion. Sun and Shenoy (2007) built naive Bayes Bayesian network models for bankruptcy prediction using operational guidance.

Plenty of techniques have been introduced to address the problem of financial prediction in recent years. Unfortunately, most of these investigations on prediction can only rely on the static model, other than a more efficient dynamic model. Thus, focusing on the short-range periodic financial data, e.g. the historic data of the $(t-1)$th year to construct the prediction state of the tth year, which basically ignore the long-term historic data. In this work we deal with the financial prediction as a dynamic statistic model based on panel data which can characterize the business failure tendency of financial distress companies. Panel data combines time-series data and cross-sectional data together and construct bi-dimension data based on time and space. Since panel data contains multitude records, it shows better performance in degree of freedom than cross-sectional data. Generally speaking, there are two ways in dealing with data mining: the one is establishment of continuous regression function, such as logit model and neural network, the other is to divide samples into different classes, for example clustering algorithm. Both theory and experiments have demonstrated that the latter performance excellently in certain cases, especially in dealing with high-dimension data. Our research is devoted to develop a more efficient complete discrete mode, in which each realistic instance is treated as a discrete module and then the financial prediction is conducted in a more efficient way.

88.2 Our Method

In 1993, for the first time, Tichy and Sherman (1993) proposed the concept of "corporate DNA". This theorem believes that, each corporate has its unique genes as human beings, and it is such an innate property determines the fundamental stable pattern, development tendency and variation. In this work, the financial information of company is regarded as a special corporate gene. Based on this new perspective, we may identify the common gene corresponding to the critical schema of financial distress, which is practically in sharp contrast to the situations of good-runned financial, and hence establish an efficient financial prediction model. In our paper, single year's financial information is converted into binary variables which will be regarded as the individual gene according to the well-designed conversation criterion. This investigation put forward a novel concept of "period gene schema" which contains several constantly years' individual gene, and expresses a company gene schema in a time series.

88.2.1 The Principle of the Schema

As the most popular coding scheme in genetic algorithms, binary coding employs the binary set {0, 1} as its coding notation set. That is, the gene expression of each population can be viewed as a binary string. Furthermore, we may add a redundant element "*", which can be referred as to wildcard and practically can be used as either the binary "0" or "1". Thus, the above binary notation set can be generalized to a ternary set, i.e., {0, 1, *}, on which the element string such as {0110, **0110, 1110*01**} can be generated. The binary string generated from the ternary set {0, 1, *}, which can depict similar structures, is referred as to a pattern. For example, the pattern *1* can describe the 4-elements subset [010, 110, 111, 011]. Accordingly, for a binary coding string with wildcard notation, there may totally involve 3^L patterns when the string length is L.

Based on this binary coding with wildcard, we may construct the binary expression from the realistic continuous data according to specific criterion. And then, the combination in time dimension is performed.

88.2.2 Mapping Rule

The first aroused question is that how we can obtain the discrete gene expression from the provided continuous financial data. With regard to the unsupervised discretization, the widely adopted method may include the equal-width and equal-frequency discretization. To be specific, in equal-width method we calculate the fixed width of each box with an equal width given a prescribed boxes number.

Assume the original continues region is denoted by [a, b], then the derived equal-width sub-space can be expressed into [a, a + (b−a)/N], [a + (b−a)/N, a + 2(b−a)/N],…,[b−(b−a)/N, b]. In this research, an improved equal-width discretization is presented. Instead of directly dividing the fixed-width space for each box, during the discretization a marginal value is adopted with which the subfield can be obtained. This marginal value is denoted with A, which is derived from average financial data for each industry by increasing or decreasing it. The extent of rise or fall will be decided in the following repeated experiments. Then the two states can be determined correspondingly through a comparison with A. Specifically, the resulting state is set to "0" when k_{ij} is smaller than A, while it is "1" if k_{ij} surpasses A. Thus, we have:

$$R = 0 \quad \text{while} \quad k_{ij} \in (-\infty, A] \tag{88.1}$$

$$R = 1 \quad \text{while} \quad k_{ij} \in [A, +\infty) \tag{88.2}$$

88.2.3 Definition of Binary Period Gene Schema

t_s: the *s*th time, (s = 1…P)
K_j: the *j*th finance index, j = 1…n
K_{ij}: the *j*th finance index of the *i*th company
R_{ij}: the gene schema of the *j*th finance index for the *i*th company, is the mapping of K_{ij}, f: K_{ij}^{ts}—R_{ij}^{ts} R_{ij}^{ts}∈{0, 1}, the mapping rules are (88.1) and (88.2).
$X_i = \{R_{i1}^{t1} \ldots R_{i1}^{tp}, R_{i2}^{t1} \ldots R_{i2}^{tp}, \ldots, R_{in}^{t1} \ldots R_{in}^{tp}\}$ which is composed of the total 26 indexes pattern R_{ij} during the successive 3 years (i.e., 2004–2006).

In this investigation, P can be empirically set to 3, which means the financial data of the past three years is utilized. Taking the Kelon Electric Appliance Company Limited for example, the total 26 financial indicators of 2002–2004 are compared with the marginal value which derived from mean value of specific industry. When the financial indicator is smaller than the corresponding marginal value, we have R = 0; and otherwise, we may set R = 1. As a consequence, the binary expression of company gene of the Kelon between the year 2004 and 2006 can be derived which also can be regarded as "period gene schema" of the Kelon Electric Appliance.

88.2.4 Building of Prediction Model

Based on the statistic technique, a prediction pattern is extracted which can efficiently distinguish the potential distressed company from those healthy ones. Due to the fact that three years' financial data are analyzed in this paper, each of index has eight kind of gene schema (000,001,010,011,100,101,110,111). We calculate the percentage of each gene schema of each index in ST sample and Non-ST sample respectively, which can be regarded as the response ratio of each index gene schema. We established the new prediction model by using this developed response ratio which generally exhibits a high percentage in distressed companies while usually shows a low percentage in healthy companies. Then under different marginal values, different predicting models can be achieved. Depends on accuracy of each model, the one which has the first-rate results would be the best predicting model.

88.3 Results

88.3.1 The Selection of Sample

Since the promulgation of company bankruptcy law, in 1986 the listed company which has gone to bankruptcy seems barely, thereby it is relatively difficult to construct the more promising analysis samples. Alternatively, the special treatment (ST) companies which be warned by China Securities Regulatory Commission is widely adopted in the most domestic existing investigations. Hence, a similar strategy is used in our analysis in which the ST companies can be thought of distressed ones while those without any special treatment (Non-ST) can be regarded as the healthy one. Besides, in order to eliminate the effects coming from different industry, the industry mean value is served as the critical value. Also, the ratio index is adopted to minimize the impact from different size. As a result, after getting rid of the companies with data deficiency and data singularity, the total 460 companies are selected as the ST and Non-ST instances with a main focus on 2006–2008. The whole sample is divided into two subsamples as the test set and the prediction set. The former contains 230 including 115 ST and 115 Non-ST companies while the later is consisted of 230 including 115 ST and 115 Non-ST companies. Considering the provided data of ST Company may exhibit noticeable fluctuations, the financial data of the years exactly before the firstly special treated are used. For example, we may construct the financial schema of a company, which has been ST firstly in 2006, by using the earlier data from 2002 to 2004.

88.3.2 The Choice of Financial Index

From the most classical literatures, 3 financial indexes have been highlighted by Beaver in (1966). In 1968, Altman employed 5 indexes in the so-called Z-score model. And lately, in 1977 he extended the total number of financial indexes to 7 in his improved model. Ohlson employed 9 significant variables in the new logit

Table 88.1 Table of indexes

Property	Index
Ability of short repaying	Current ratio, quick ratio
Ability of long repaying	The ratio net working capital and total assets, debt ratio, the ratio of long-term liabilities and net working capital, the debt-equity ratio, the stockholders' equity ratio, long-term debt to total asset ratio
Cash flowing	The ratio of cash flow and liabilities, cash ratio
Earning	Net profit on sales, net profit on total assets, the ratio of net assets and net profit, the ratio of operating profits and costs and expenses
Development	The growth rate of fixed assets, the growth rate of total assets, the growth rate of net profit
Operating	The ratio of operating ratio, the ratio of management expenses and main business income, financial ratio, fixed asset ratio, inventory turnover. Fixed asset turnover, current assets turnover, the assets turnover, the stockholders' equity turnover

model. By combining these famous indexes which have been adopted by most other investigations, in this work we may use 26 fanatical indexes which can reflect the most property of a company, such as the ability of short repaying, long repaying, cash flowing, earning, development and operating. Table 88.1 embodies the indexes.

88.3.3 Prediction of Model

Table 88.2 has illustrated the response ratio of some ST and Non-ST companies under each financial index when marginal value is 15 % up to the average one. Ration of ST represents the percentage of each schema under different indexes in ST samples, as the same, ration of Non-ST is the percentage of each schema under different indexes for Non-ST samples. Difference between ST and Non-ST means the difference value between Ration of ST and Ration of Non-ST for the same schema under same index. Take "current ratio" for example, response ratio of schema "000" is 17.24 % for ST companies in comparison to 2.59 % for Non-ST companies. Among the eight schema of index "current ratio", the schema "111" has the greatest difference between ST and Non-ST samples, so we can safely come to the conclusion that "111" is the best schema of "current ratio" under 15 % up marginal value. Based on our repeatedly empirical experiments, we may choice the marginal value rising 15 % over the exactly mean value, and choice the schemas with their ST ratio being 15 % larger than those of Non-ST. Table 88.3 expresses different prediction on different marginal value according to various extent to the change of very value of each industry. The resulting significant schemas include the 111 pattern of financial expenses ratio, the 000 pattern of current ratio and the 111 pattern of financial ratio, with which the prediction

Table 88.2 Table of schema ratio

Index	Schema	Ration of ST	Ration of non-ST	Difference between ST and non-ST
Current ratio	000	0.1724	0.0259	0.1465
	001	0.0172	0.0172	0
	010	0.0086	0	0.0086
	011	0.0517	0.0345	0.0172
	100	0.0431	0.0345	0.0086
	101	0.0172	0.0259	−0.0087
	110	0.0172	0.069	−0.0518
	111	0.8103	0.6379	0.1724
Financial ratio	000	0.7586	0.5259	0.2327
	001	0.0431	0.0431	0
	010	0.0086	0.0259	−0.0173
	011	0	0.0345	−0.0345
	100	0.0603	0.0948	−0.0345
	101	0.0086	0.0172	−0.0086
	110	0.0603	0.0431	0.0172
	111	0.0517	0.2069	−0.1552
The ratio net working capital and total assets	000	0.431	0.2414	0.1896
	001	0.0431	0.0172	0.0259
	010	0.0086	0.0172	−0.0086
	011	0.0086	0.0259	−0.0173
	100	0.0603	0.0345	0.0258
	101	0.0259	0.0172	0.0087
	110	0.1034	0.0517	0.0517
	111	0.3103	0.5862	−0.2759

Table 88.3 Table of accuracy

Extent to the very value	Index	Shcema	Accuracy
0 %	Current ratio	000	0.7826
	Quick ratio	000	0.7130
	Financial ratio	111	0.8067
	Current ratio and quick ratio	000, 000	0.6700
Up 15 %	Current ratio	000	0.8609
	Financial ratio	111	0.8000
	Current ratio and financial ratio	000, 111	0.7565
Down 15 %	Current ratio	000	0.7217
	Financial ratio	111	0.8435
	Current ratio and financial ratio	000, 111	0.6700
Up 20 %	Current ratio	000	0.8522
	Financial ratio	111	0.8087
	Current ratio and financial ratio	000, 111	0.7304
Down 20 %	Current ratio	000	0.6348
	Financial ratio	111	0.8170

accuracy can be improved to 86.09 and 80 % from the experiments. There also has significant prediction for the combination of the 000 pattern of current ratio and the 111 pattern of financial ratio, which can achieved 75.65 %.

88.4 Conclusion

Traditional methods for constructing stable prediction model often lie in single year data, which cannot embody the trend before ST. According to schema theory of genetic algorithm, this paper presents a panel data mining method based on binary variables. We can see that the prediction of the new method no less than classic ones, meanwhile the principle is simple, it can be helpful to providing qualified information for interest-related parts. There still are some aspects could be improved. This research uses statistic method when establish the prediction model, however, any other advantaged techniques can be applied in, such as genetic algorithm. Furthermore, the schema which contains "*" also could be researched in the prediction model.

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Chapter 89
Capacity Planning with Cooperative Resources

Shuai Li, Zhi-cong Zhang, Shao-yong Zhao and Kai-shun Hu

Abstract In particular production environment, e.g. some machining shops and semiconductor test stations, multiple resources are simultaneously needed to perform an operation. To conduct capacity planning with cooperative resources, we propose two methods to construct compact linear programming models, i.e. Generalized Step-Separated Formulation and Generalized Workload Allocation Formulation. These modeling methods are extended from the existing modeling methods for capacity planning only with independent resources. Generalized Workload Allocation Formulation weakens the application scope of the uniformity assumption made in the previous formulation for independent resources. Dimension analysis and comparison shows that Generalized Workload Allocation Formulation generates less decision variables and constraints than Generalized Step-Separated Formulation.

Keywords Capacity planning · Cooperative resources · Linear programming · Formulation

89.1 Introduction

Capacity planning aims to determine the optimal tool set configuration according to the demand or determine the optimal product mix due to the available tool sets. The approaches applied in capacity planning include spreadsheets (Occhino 2000),

S. Li (✉) · Z. Zhang · S. Zhao · K. Hu
Department of Industrial Engineering, School of Mechanical Engineering,
Dongguan University of Technology, Dongguan, China
e-mail: lishuai@dgut.edu.cn; stephen1998@gmail.com

S. Zhao
e-mail: zhaosy@dgut.edu.cn

K. Hu
e-mail: huks@dgut.edu.cn

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discrete event simulation (Toba 2005), queuing theory (Jeong 2005; Liu et al. 2011), mathematical programming (Lin et al. 2011; Karabuk and Wu 2002), and heuristic algorithms, e.g. beam search algorithm (Özpeynirci and Azizoğlu 2009) and Tabu Search (Bilgin and Azizoğlu 2009).

Linear programming (LP) and mixed integer linear programming (MILP) are used more frequently in capacity planning. Swaminathan (2000) studied machine procurement in aggregate capacity planning and proposed an alternative operations allocation model, in which utilization and stock-out cost measures are used. He found tool procurement policies capable of dealing with the uncertainty in future demands for various products, respectively for single-period and multi-period planning. Christie and Wu presented a Multistage Stochastic Linear Programming (MSLP) model for strategic capacity planning to minimize the gap between capacity demands and capacity allocation (Christie and Wu 2002). The MSLP model is qualified to evaluate the robustness of a particular technology scenario analysis. Hood et al. (2003) employed stochastic integer programming to find tool set configuration robust to demand uncertainty. LP formulations generate numerous decision variables and constraints for complicated production environments (Ahmed et al. 2003). Aiming to develop capacity models with less decision variables and constraints, Leachman and Carmon (1992) proposed Step-Separated Formulation, Workload Allocation Formulation and Direct Product Mix Formulation to model alternative machine capacity problems. In order to remove the uniformity assumption, Hung and Cheng (2002) combined the Workload Allocation Formulation and the Direct Product Mix Formulation and proposed a capacity partition technique more suitable for industrial application.

Most existing capacity planning models assume that an operation is performed by a single unit of resource, that is, all the units of all types of resources are used independently. However, in some cases, multiple resources called cooperative resources are used simultaneously to perform an operation. Sometimes capacity planning approaches for independent resource usage can not cope with the case of cooperative resources (Barahona et al. 2005). In this paper, we allow the reconfiguration of all resource unions at any time, that is, one unit of resource can be involved in different resource unions for different products during a period if necessary. Consequently, we optimize the resources allocation to a higher level.

89.2 Problem Statement and Formulation

A typical capacity planning problem with cooperative resources involves two components: a set of resource types and a set of product types. Each product type requires a set of operations with precedence relations to be performed. Each operation requires specific raw materials or parts, and a union of resources to cooperate simultaneously. One resource union may contain one or more types of resources and one resource type may belong to different resource unions.

The whole planning horizon is divided into a number of periods. We suppose that no internal inventory is among the operations and the average flow time of any operation of any product is a multiple of the length of a period, so the workload of any operation in any time bucket can be calculated based on the workload allocated to the start operation in each period. We also assume that the forecasted demand is deterministic, back order is not allowed, and related materials are always available. The optimality objective is to maximize the profit.

In the following we propose two LP formulations: Generalized Step-Separated Formulation (GSSF) and Generalized Workload Allocation Formulation (GWAF).

89.2.1 Notation

Indexes and sets are introduced as follows.

i = 1, … , N	Product type index.
j = 1, … , J_i	Operation index, where J_i denotes the number of operations of product type i.
t = 1, … , T	Time period index, where period t denotes the time interval ($t-1$, t].
r = 1, … , R	Resource type index.
$RS_{i,j}$	The set of resource unions capable of performing operation (i, j).
$R_{i,j,k}$	The kth resource union capable of performing operation (i, j), where $R_{i,j,k} \in RS_{i,j}$, k = 1, …, $K_{i,j}$.

Parameters are introduced as follows.

$L_{i,j}$	Average flow time for product i from the beginning of the first operation to the start of operation j.
L_i	Average flow time of all the operations for product i.
NI_r	Quantity of resource r at the beginning of the planning horizon.
$CP_{r,t}$	The cost incurred by purchasing one unit of resource r at the beginning of period t.
BU_t	Budget upper bound for purchasing new resource in period t.
$m_{i,j,k}$	The processing time (hour) of one unit of operation (i, j) by resource union $R_{i,j,k}$.
$RT(r, ru)$	The matching ratio of resource r in resource union ru containing r, i.e. the number of resource r in one unit of ru.
$TA_{r,t}$	Available working hours of one unit of resource r in period t.
$D_{i,t}$	Forecasted demand of product i in period t.
$p_{i,t}$	The net cash flow from selling one unit of product type i in period t, deducting the material cost.
$h_{i,t}$	The cost of holding one unit of product type i at the end of period t.
$q_{i,t}$	Shortage cost of one unit of product type i in period t.
$f_{r,t}$	Operation cost of one unit of resource r per hour in period t.

$IL_{i,t}$	Safety inventory for product i at the end of period t.
$IH_{i,t}$	Upper bound of inventory level for product i at the end of period t.

Decision variables are introduced as follows.

$X_{i,t}$	Quantity of product i dispatched in period t.
W_{i,t_1,t_2}	Quantity of product i dispatched in period t_1 and processed in period t_2 ($t_1 + 1 \le t_2 \le t_1 + L_i$), where $t_1 + L_{i,j-1} + 1 \le t_2 \le t_1 + L_{i,j}$ means the products are processed on operation j.
$\mathrm{Y_{i,j,k,t}}$	The workload of product i on operation j assigned to resource union $R_{i,j,k}$ in period t.
$I_{i,t}$	Quantity of finished product i held in inventory at the end of period t.
$DS_{i,t}$	Unsupported demand of product i in period t.
$NP_{r,t}$	Quantity of resource r purchased at the beginning of period t.

89.2.2 Generalized Step-Separated Formulation

$$\begin{aligned} & Max \sum_{t=1}^{T} \sum_{i=1}^{N} (p_{i,t} X_{i,t-L_i} - h_{i,t} I_{i,t} - q_{i,t} DS_{i,t}, \\ & - \sum_{j=1}^{J_i} \sum_{k=1}^{K_{i,j}} \sum_{r \in R_{i,j,k}} f_{r,t} m_{i,j,k} Y_{i,j,k,t} - \sum_{r=1}^{R} CP_{r,t} NP_{r,t} \end{aligned} \tag{89.1}$$

Subject to workload consistency and allocation constraints:

$$\begin{gathered} X_{i,t} = \sum_{\tau=1}^{L_{i,j+1}-L_{i,j}} W_{i,t,t+L_{i,j}+\tau} \\ \forall\ i = 1,\ldots,N;\ j = 1,\ldots,J_i;\ t = 1,\ldots,T \end{gathered} \tag{89.2}$$

$$\begin{gathered} \sum_{\tau=1}^{L_{i,j+1}-L_{i,j}} W_{i,t-L_{i,j}-\tau,t} = \sum_{k=1}^{K_{i,j}} Y_{i,j,k,t} \\ \forall\ i = 1,\ldots,N;\ j = 1,\ldots,J_i;\ t = 1,\ldots,T \end{gathered} \tag{89.3}$$

Capacity constraint:

$$\begin{gathered} \sum_{(i,j,k)|r \in R_{i,j,k}} RT(r, R_{i,j,k}) m_{i,j,k} Y_{i,j,k,t} \le (NI_r + \sum_{\tau=1}^{t} NP_{r,\tau}) TA_{r,t} \\ \forall\ r = 1,\ldots,R;\ t = 1,\ldots,T \end{gathered} \tag{89.4}$$

Budget constraint:

$$\sum_{r=1}^{R} CP_{r,t} NP_{r,t} \le BU_t \quad \forall\ t = 1,\ldots,T \tag{89.5}$$

Inventory constraint:

$$IL_{i,t} \le I_{i,t} \le IH_{i,t} \quad \forall\, i = 1, \ldots, N; t = 1, \ldots, T \tag{89.6}$$

Demand constraint:

$$\begin{aligned} X_{i,t-L_i} - I_{i,t} + I_{i,t-1} + DS_{i,t} = D_{i,t} \\ \forall i = 1, \ldots, N; t = 1, \ldots, T \end{aligned} \tag{89.7}$$

Non-negative constraint:

$$\begin{gathered} X_{i,t} \ge 0,\ W_{i,t_1,t_2} \ge 0,\ Y_{i,j,k,t} \ge 0,\ NP_{r,t} \ge 0,\ I_{i,t} \ge 0,\ Ds_{i,t} \ge 0 \\ \forall\ i = 1, \ldots, N;\ j = 1, \ldots, J_i;\ k = 1, \ldots, K_{i,j};\ r = 1, \ldots, R;\ t,\ t_1,\ t_2 = 1, \ldots, T \end{gathered} \tag{89.8}$$

The objective function aims to maximize the profit of the whole planning horizon, which equals the overall net cash flow subtracting the inventory cost, the shortage cost, the operation cost of all resources, and cost incurred by purchasing resources. Constraint (89.2) represents the relationship between dispatching for a product and its workload allocated over the flow time of all its operations, assuming the yield of each operation is 100 %. Constraint (89.3) describes the workload conservation of any product and operation in any period. For example, suppose that $L_{i,j+1} - L_{i,j} = 3$, that is, the average flow time of operation j of product i is three. As illustrated in Fig. 89.1, the products dispatched in period t, denoted $X_{i,t}$ and represented as block *D1*, will be processed on operation j in the duration from period $t + L_{i,j} + 1$ to $t + L_{i,j} + 3$, denoted $W_{i,t,t+L_{i,j}+1}$, $W_{i,t,t+L_{i,j}+2}$ and $W_{i,t,t+L_{i,j}+3}$ respectively, and respectively represented as block $j11$, $j12$ and $j13$; the products start in period $t + 1$, denoted $X_{i,t+1}$ and represented as block D2, will be processed on operation j in the duration from period $t + L_{i,j} + 2$ to $t + L_{i,j} + 4$, denoted $W_{i,t+1,t+L_{i,j}+2}$, $W_{i,t+1,t+L_{i,j}+3}$ and $W_{i,t+1,t+L_{i,j}+4}$ respectively, and represented as block $j21$, $j22$ and $j23$ respectively; and so forth. Consequently, the accumulated workload associated with operation j of product i in period $t + L_{i,j} + 3$ is the sum of $W_{i,t,t+L_{i,j}+3}$, $W_{i,t+1,t+L_{i,j}+3}$ and $W_{i,t+2,t+L_{i,j}+3}$. Constraint (89.4) ensures that the required working hours of each

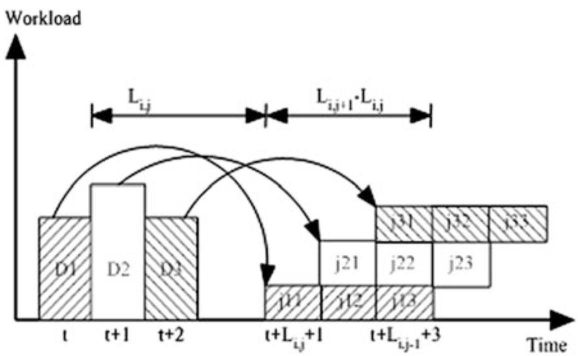

Fig. 89.1 Workload consistency and allocation constraint for product i on operation j

resource in each period do not violate its capacity, the available working hours. Constraint (89.5) guarantees that the cost of purchasing all sorts of resources is under budget constraint in each period. Constraint (89.6) states that inventory level of each product is between its lower bound and upper bound. Constraint (89.7) states the relationship between production volume, inventory depletion and demand. Products i finished in period t are dispatched L_i period before.

89.2.3 Generalized Workload Allocation Formulation

We extend the Workload Allocation Formulation based on the uniformity assumption to the general case that not all the resource unions are required to satisfy the uniformity assumption. The qualification relationship between operations and resource unions is shown in Fig. 89.2. We introduce the following notation for developing GWAF.

R_u (u = 1, …, U). The unique set of resource unions among the sets $RS_{i,j}$, qualified to perform all the operations in operation set O_u. We have $O_{u1} \cap O_{u2} = \Phi(u1 \neq u2)$. But R_{u1} and $R_{u2}(u1 \neq u2)$ are not required to be exclusive, i.e. R_{u1} and R_{u2} may have common elements, resource unions. One type of resource may belong to multiple resource unions.

RA_u ($RA_u \subseteq R_u$). The subset of R_u, in which the resource unions satisfy the uniformity assumption.

$m_{i,j}$. The processing time of one unit of operation (i, j) with standard resource union.

$Z^u_{v,t}$. The workload on set R_u assigned to resource union v (v ∈ R_u) in period t, represented as the processing time by standard resource union.

Workload consistency and allocation constraints:

Constraint (89.2) is also needed in this formulation. Constraint (89.3) can be presented as constraints (89.9) and (89.10), where $RA_u = \Phi$ means that no resource unions in R_u satisfy the uniformity assumption. Under the uniformity assumption, the workload of different operations performed by RA_u can be scaled according to the standard resource union.

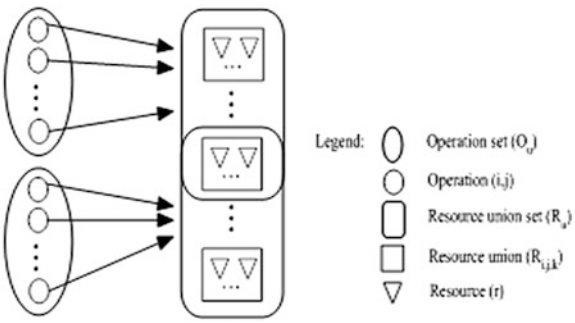

Fig. 89.2 Qualification relationship between operations and resource unions

$$\sum_{(i,j)\in O_u} m_{i,j}\Big(\sum_{\tau=1}^{L_{i,j+1}-L_{i,j}} W_{i,t-L_{i,j}-\tau,t} - \sum_{\mathrm{R_{i,j,k}}\in \mathrm{R_u}-\mathrm{RA_u}} Y_{i,j,k,t}\Big) = \sum_{v\in RA_u} \mathrm{Z^u_{v,t}},\ \Phi \quad (89.9)$$
$$\forall u = 1,\ldots,U \text{ and } \mathrm{RA}_u \neq \Phi; t = 1,\ldots,T$$

$$\sum_{\tau=1}^{L_{i,j+1}-L_{i,j}} W_{i,t-L_{i,j}-\tau,t} = \sum_{k=1}^{K_{i,j}} Y_{i,j,k,t} \quad (89.10)$$
$$\forall\ RS_{i,j} = \mathrm{R_u} \text{ and } \mathrm{RA_u} = \Phi; t = 1,\ldots,T$$

Capacity constraint:

$$\sum_{i=1}^{N}\sum_{j=1}^{J_i}\sum_{\{k|R_{i,j,k}\in RA_u, r_{i,j,k}\}} RT(r, R_{i,j,k})\frac{\mathrm{m_{i,j,k}}}{\mathrm{m_{i,j}}}\mathrm{Z}^{\mathrm{u}}_{R_{i,j,k},\mathrm{t}}$$
$$+\sum_{i=1}^{N}\sum_{j=1}^{J_i}\sum_{\{k|R_{i,j,k}\in(R_u-RA_u), r\in R_{i,j,k}\}} m_{i,j,k}Y_{i,j,k,t} \le C_{r,t} \quad (89.11)$$
$$\forall\ r = 1,\ldots,R; t = 1,\ldots,T$$

GWAF divides the workload on resource union set $\mathrm{R_u}$ into two partitions respectively performed by $\mathrm{RA_u}$ and $\mathrm{R_u} - \mathrm{RA_u}$. Correspondingly, the resource usage is also divided into partitions: one is for $\mathrm{RA_u}$ and the other is for $\mathrm{R_u} - \mathrm{RA_u}$. The other constraints and the objective function are the same as those in GSSF.

89.3 Dimension Analysis and Comparsion

In this section, we analyze the general case dimension of GSSF and GWAF. The number of decision variables $X_{i,t}$, W_{i,t_1,t_2}, $I_{i,t}$, $DS_{i,t}$ and $NP_{r,t}$ are identical in the two formulations. We neglect these common decision variables and focus on the allocation variables in workload consistency and allocation constraints, and capacity constraints which are different in dimension in the two formulations. The numbers of workload consistency and allocation constraints are different in the two formulations, while the numbers of the other constraints are the same. Therefore, we only care about workload consistency and allocation constraints in this section.

In GSSF, $\mathrm{Y_{i,j,k,t}}$ is the allocation variable. The number of $\mathrm{Y_{i,j,k,t}}$ per period is $Q_{SV} = \sum_{i=1}^{N}\sum_{j=1}^{J_i} K_{i,j}$, where $K_{i,j}$ is the number of resource unions qualified to perform operation $(i,\ j)$. Workload consistency and allocation constraint includes constraints (89.2) and (89.3). However, constraint (89.2) is common in two formulations, so we only examine the quantity of constraint (89.3). The number of constraint (89.3) per period is $Q_{SC} = \sum_{i=1}^{N} J_i$.

In GWAF, $\mathrm{Y_{i,j,k,t}}$ and $\mathrm{Z^u_{v,t}}$ are allocation variables. In the case $\mathrm{RA_u} = \Phi$, the number of $\mathrm{Y_{i,j,k,t}}$ per period is $\sum_{u|\mathrm{RA_u}=\Phi} |\mathrm{R_u}||O_u|$, while allocation variable $\mathrm{Z^u_{v,t}}$ is not required. In the case $\mathrm{RA_u} \neq \Phi$, the number of $\mathrm{Z^u_{v,t}}$ per period is $\sum_{u|\mathrm{RA_u}\neq\Phi} |\mathrm{RA_u}|$ and the number of $\mathrm{Y_{i,j,k,t}}$ per period is $\sum_{u|\mathrm{RA_u}\neq\Phi} |\mathrm{R_u} - \mathrm{R\sim_u}||O_u|$. Thus, the total number of allocation variables per period is

$$\begin{aligned} Q_{WV} &= \sum_{u|\mathrm{RA_u}\neq\Phi} |\mathrm{RA_u}| + |\mathrm{R_u} - \mathrm{R\sim_u}||O_u| + \sum_{u|\mathrm{RA_u}=\Phi} |\mathrm{R_u}||O_u| \\ &\leq \sum_{u|\mathrm{RA_u}\neq\Phi} (|\mathrm{RA_u}| + |\mathrm{R_u} - \mathrm{R\sim_u}|)|O_u| + \sum_{u|\mathrm{RA_u}=\Phi} |\mathrm{R_u}||O_u| \\ &= \sum_u |\mathrm{R_u}||O_u| \leq Q_{SV} \end{aligned} \tag{89.12}$$

Constraints (89.9) and (89.10) in GWAF are workload consistency and allocation constraints as constraint (89.3) in GSSF. Apparently, the number of constraints (89.9) and (89.10) per period are respectively $|\{\mathrm{u}|\mathrm{RA_u} \neq \Phi\}|$ and $\sum_{u|\mathrm{RA_u}=\Phi} |O_u|$. Hence, the total number of constraints (89.9) and (89.10) is

$$\begin{aligned} Q_{WC} &= |\{\mathrm{u}|\mathrm{RA_u} \neq \Phi\}| + \sum_{u|\mathrm{RA_u}=\Phi} |O_u| \\ &\leq \sum_{u|\mathrm{RA_u}\neq\Phi} |O_u| + \sum_{u|\mathrm{RA_u}=\Phi} |O_u| \\ &= \sum_u |O_u| = Q_{SC} \end{aligned} \tag{89.13}$$

Hence, the numbers of decision variables and constraints of GWAF are both less than those of GSSF. GWAF is more compact because the resource unions fulfilling the uniformity assumption are regarded as a whole in workload allocation. In fact, the two formulation techniques are equivalence when none of the resource unions satisfies the uniformity assumption. GSSF and Workload Allocation Formulation are two extreme cases of GWAF. In other words, GWAF combines the advantage of GSSF and Workload Allocation Formulation.

Trivially, some latter operations are impossible to be performed in the starting periods because flow time of each operation is assumed to be fixed. Let $NO_{i,t}$ denote the number of possible operations of product i in period t. Thus,

$$NO_{i,t} = \begin{cases} j & L_{i,j} < t \leq L_{i,j+1} \\ J_i & t > L_i \end{cases} \tag{89.14}$$

Therefore, the number of allocation variables and constraints of the two formulations is a little less than showed in Table 89.1.

Table 89.1 Comparison of the dimensions of the two formulations

	Number of allocation variables per period	Number of workload consistency and allocation constraints [except constraint (89.2)] per period
GSSF	$\sum_{i=1}^{N}\sum_{j=1}^{J_i} K_{i,j}$	$\sum_{i=1}^{N} J_i$
Modified workload allocation formulation	$\sum_{u\|\mathrm{RA_u}\neq\Phi} \|\mathrm{RA_u}\| + \|\mathrm{R_u}-\mathrm{RA_u}\|\|O_u\| + \sum_{u\|\mathrm{RA_u}=\Phi} \|\mathrm{R_u}\|\|O_u\|$	$\|\{\mathrm{u}\|\mathrm{RA_u}\neq\Phi\}\| + \sum_{u\|\mathrm{RA_u}=\Phi} \|O_u\|$

89.4 Conclusions

Most of the previous research on capacity planning focused on independent resources usage. However, applying the planning approaches concerned with independent resources usage to the case of cooperative resources may result in infeasible plans. We extend Step-Separated Formulation and Workload Allocation Formulation which are only applicable to independent resources usage to two compact enhanced formulations, i.e. GSSF and GWAF, which are capable to cope with cooperative resources usage. In addition, GWAF relaxes the scope of uniformity assumption and integrates Step-Separated Formulation and Workload Allocation Formulation. Theoretical comparison indicates that it is more compact than GSSF. We also develop the formulation applicable to the case of multiple matching ratios and optimizing capacity planning at the most precise level, the unit level.

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Chapter 90
A Study of the Application Scope of Valuation Principles of Project Variation

Ying Li, Ling-jie Han and Xiao-dong Zhang

Abstract The three Principles of valuation of engineering variation have become the universal principles. Nevertheless, the uncertainty of the three principles has caused a lot of disputes. The paper analyzed the relationship between the changing reason of comprehensive unit price of variation and the three principles, suggested the scope of application of the three principles. The achievement has some practicable meaning to contracting parties deal with the variation disputes.

Keywords Comprehensive unit price of variations · Principles of valuation · Project variation · Scope of application

90.1 Introduction

Project variation is the main factor of the price adjustment. According to this study, the amount of project price adjustment caused by variations account for about 5 to 10 % of the total price of the construction and installation works, some items more than 30 % or more (Hong 2009). Kamrul and Indra (2010) analyzed 149 under-investment international engineering projects, 17.45 % of which is caused by variations. Laws and regulations and model contracts have set provisions about variation, classifying the provisions into three types. The first one is such items about appropriate price in the Contract (Hereinafter referred to as "the first principle of

Y. Li (✉)
School of Management, Tianjin University of Technology, Tianjin, China
e-mail: 568419805@qq.com

L. Han
Enterprise Management Department, Guqiao Mine of Huainan Mining Group, Huainan, China

X. Zhang
China Petroleum Pipeline Bureau Tianjin Design Institute, Tianjin, China

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valuation"). The second one is such item about similar price (Hereinafter referred to as "the second principle of valuation"). The third one is that there is no item about price (Hereinafter referred to as "the third principle of valuation"). However, there are many disputes during the application process of the three principles. The main reason is that there is no explanation about how to adapt the three principles in the laws and regulations. Thus, studying the applicable scope of the three principles will be a certain practical significance for carrying out the variation smoothly and reducing disputes between owner and contractor.

90.2 Analysis of Relationship Between Three Evaluation Principles and the Composition of Comprehensive Unit Price of Variations

When price adjustment occurs due to project variation, only labor cost, materials cost and operating cost of machinery need to be adjusted. Because the other two parts, management cost and profit, among the comprehensive unit price equal the sum of labor cost, materials cost and operating cost of machinery of comprehensive unit price of variations multiplied by the rate of management and profit in the tender offer. Thus, comprehensive unit price of variations compared to comprehensive unit price of tender offer, only labor cost, materials cost and operating cost of machinery are changed.

According to the diversification of comprehensive unit price of variations, the principle of evaluation can be defined when project variation occurs.

90.2.1 Analysis of the Relationship Between the Composition of Comprehensive Unit Price of Variations and the First Principle of Evaluation

Obviously, the first principle of evaluation means that there is the same comprehensive unit price in the contract with the comprehensive unit price of variation program.

90.2.2 Analysis of the Relationship Between the Composition of Comprehensive Unit Price of Variations and the Second Principle of Evaluation

The change of labor cost, materials cost and operating cost of machinery can be divided into two kinds, such as the proportion of change and non-proportional change. And the non-proportional change includes three cases, one change, two changes or three changes. According to literature review, many scholars agreed that the first principle of evaluation can be applied when labor cost, materials cost and operating cost of machinery change proportionally or only one of them changes. For there are two changes of labor cost, materials cost and operating cost of machinery, the third principle of evaluation should be used on the basis of its pricing process—Firstly, identify norm content of items of B.Q of variation project. Then replace the items of original comprehensive price into items of variation project. Finally, identify the comprehensive unit price of variation project.

90.2.3 Analysis of the Relationship Between the Composition of Comprehensive Unit Price of Variations and the Third Principle of Evaluation

According to the analysis of Sects 90.2.1 and 90.2.2, we can have the conclusion that the third principle of evaluation can be used in two cases—when two of labor cost, materials cost and operating cost of machinery changing, or all of them change non-proportionally. The map respected the relationship between the composition of comprehensive unit price of variations and three types of principle of evaluation can be draft. The map is shown in Fig. 90.1.

90.3 Analysis of the Reason that the Composition of Comprehensive Unit Price Change Caused by Project Variation

Project variation would lead to change of subject matter of project. The change of labor cost, materials cost and operating cost of machinery is the reason that the change of the comprehensive unit price of project variation. For the reason caused the change of the comprehensive unit price, scholars made a lot of studies, as shown in the Table 90.1.

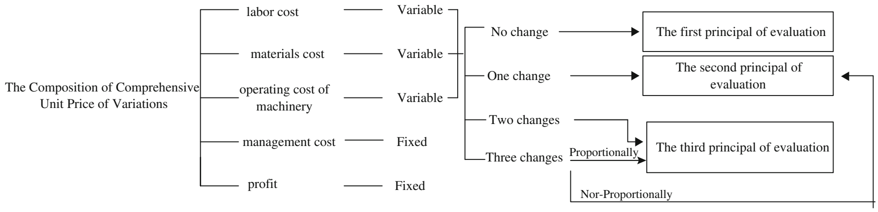

Fig. 90.1 The relationship between the composition of comprehensive unit price of variations and three types of principle of evaluation

Table 90.1 Analysis of the reason that the composition of comprehensive unit price change

Reason Scholar	Material	Construction technology	Quantity change in a large range	Draft design change	Unbalanced bidding	Construction conditions and environment
Sun and Shen (2009)	√	√	√			
Ke (2008)	√	√				
Wu and Zhu (2007)	√	√	√	√	√	√
Yan and Zhao (2010)	√	√	√	√	√	√
Wu (2006)			√			√
Liao (2003)			√			
Xu (2006)	√	√	√	√		
Shuai (2009)			√	√		
Guo (2005)			√	√		
Lin (2009)			√			
Zhao (2009)	√		√	√		
Guangxian (2007)						√
Guo (2003)	√		√			
Xie (2009)		√				
Du and He (2010)	√	√	√			

According to scholars' research, the main reason of price adjustment caused by project variation include: (1) the change of material; (2) the change of construction technology and method; (3) Quantity change in a large range; (4) Draft design change; (5) unbalanced bidding; (6) the change of construction conditions and environment.

(1) The change of materials means to change the cost of materials only in the original unit price. (2) The change of construction technology and method, means to change labor cost, materials cost and operating cost of machinery, such as, excavation in hand are replaced by excavator. (3) For quantities change in a large range, the laws ruled that only the comprehensive unit price can be adjusted for whose quantity beyond the contract. Furthermore, most of the scholars agreed that only the management cost and profit need to be changed, and labor cost, materials cost and operating cost of machinery have no need to change. (4) Draft design changes can be divided into two categories, one is the construction technology and method changing, the other is construction content change proportionally, which is labor cost, materials cost and operating cost of machinery change proportionally. (5) Unbalanced bidding means that the bidding of labor cost, materials cost and operating cost of machinery is unreasonable. The price should be re-priced. (6) Changes of construction conditions and environment maybe lead to construction technology and method change, which in fact is the second reason.

In summary, the main reason of price adjustment caused by project variation include: (1) Change of material; (2) Change of construction technology and method; (3) Quantity change in a large range; (4) Draft design change, but construction technology and method, environment and material don't change; (5) Unbalanced bidding.

90.4 Define the Scope of Application of Evaluation Principles of Variation

In Summary, change of material belongs to the second evaluation principle. Change of construction technology and method belong to the third evaluation principle. When quantities' change amplitude are out of scope agreed in contract, the comprehensive unit price need to be re-priced, so this kind of variation applied to the third evaluation principle. When draft design changes, but construction technology and method, environment and material don't change, this kind of variation applied to the second evaluation principle. Unbalanced bidding would lead to the comprehensive unit price re-priced, so it applied to the third evaluation principle. Figure 90.2 shows the specific classification.

According to the above study, the scope of application of evaluation principles of variation can be determined as follows.

90.4.1 The Scope of Application of the First Evaluation Principle of Variation

The variation of comprehensive unit price existing in the contract should meet all the following characteristics:

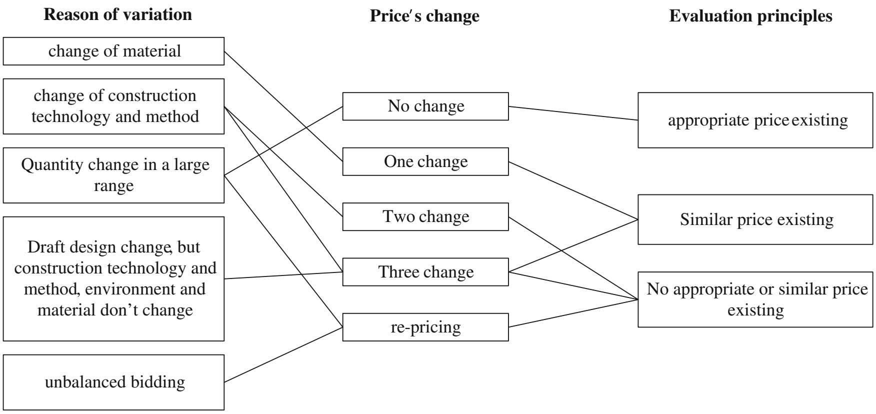

Fig. 90.2 The scope of application of evaluation principles of variation

1. The items of variation have the same nature with the items in the contract means that they have the same drawing dimension, the same construction technology and method, the same material;
2. The items of variation have the same construction conditions with the items in the contract;
3. Project quantities of variation don't exceed the scope agreed in the contract;
4. The price of the original contract was not significantly high or low;
5. Variations don't change the construction time of the critical path.

90.4.2 The Scope of Application of the Second Evaluation Principle of Variation

The variation of similar comprehensive unit price existing in the contract should meet at least one of the following characteristics:

1. The items of variation compared to the item of original contract, only the nature of materials changed, but the consumption of labor, material and machine didn't changed. Such as, strength of cement changed from C20 to C25.
2. The items of variation compared to the item of original contract, only the draft design changed, but construction technology and method, and environment didn't change. Such as, the thickness of leveling layer of cement mortar changed.

Moreover, variation shall not change the construction time, nor there was a clear unbalanced bidding.

90.4.3 The Scope of Application of the Third Evaluation Principle of Variation

The variation of no appropriate or similar comprehensive unit price existing in the contract should meet at least one of the following characteristics:

1. The items of variation have different nature with the items in the contract. Variation generated new work, so new price emerged and the original price wouldn't be used any more;
2. Construction environment was changed because of variation;
3. Change of quantities and price beyond the scope agreed in the contract;
4. Contractor introduced obvious unbalanced bidding in the original contract;
5. Variations changed the construction time of the critical path.

90.5 Conclusion

Solving the problem of the applicability of three principles for evaluating project variation is an important prerequisite for applying the three principles to dealing with project variation events. The paper has summarized five situations of project variation and defined respectively the applicable scope of the five situations. It provides important reference for processing project variation events and has certain practical significance for decreasing the amount of project variation event. Otherwise, on the basis of existing research, how to ascertain the comprehensive unit price of variation by using the three principles of evaluation and how to deal with the variation disputes, will be the key point of my future study.

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Chapter 91
Study on Process Reengineering of Coal Mine Ventilation Area

Jing-wen An, Zhi-qiang Zhang and Xiao-chuan Wang

Abstract Based on the theory and method of process reengineering, this paper implemented process engineering on ventilation area of A Coal Mine. On the basis of analysis, diagnosis and optimization on existing situation, organizational structure and process system were reengineered, and related management system was established. That shows that BPR is an important way for coal mines to standardize management, enhance organization and coordination flexibility, promote efficiency and benefit.

Keywords Coal mine · Process reengineering · Ventilation area · Study

91.1 Introduction

With the rapid development of the world economy and technology, since the 1980s, the uncertainty of the enterprise survival environment is increasing, the competition which enterprises are facing is also becoming increasingly fierce, which mainly reflected the competition of five respects (price, quality, variety, time and service). Only the one who has advantages in these five respects can survive and develop. Enterprises used a lot of advanced manufacturing technology and management methods, and the comprehensive use of these technology and methods, indeed, has improved and enhanced the competitiveness of enterprises. However, among them, in terms of the aspect of strategy process reengineering is the most effective method to improve the competitiveness of the enterprise (He and Wu 2011).

J. An · Z. Zhang (✉) · X. Wang
School of Management, China University of Mining and Technology, Beijing, China
e-mail: zzqhot@126.com

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Underground coal mining must work to dig a series of roadway from ground to underground, the production process is underground work, natural condition is very complex and the mining process need ventilation, during mining there are five disasters: the gas, coal dust, roof, fire and water. “One ventilation and three prevention” is short for the technical management work on mine ventilation, gas prevention, dust prevention and fire prevention. “One ventilation and three prevention” is an important part of coal mine safety, coal mine ventilation professional level directly affect the whole safety conditions of the coal mine. However, at present, the coal mine ventilation department usually have some problems, such as unreasonable organization structure, unclear duty, unsmooth flow and so on, which all directly affect the coal mine safety work. Therefore, it is necessary for coal mine ventilation department to do process reengineering to realize the goal of smooth process flow, efficient organization and hard working person of process reengineering (Dong 2008).

By using BPR thoughts and methods on ventilation area of A Coal Mine as an example, this paper states that the coal mines especially the departments whose standardization management are weak, after the systematical analysis and careful arrangement and reengineering process, can effectively standardize organization management, enhance the organization and coordination flexibility and promote efficiency and benefit.

91.2 Process Reengineering Theory

91.2.1 The Concept of Process Reengineering

3C (Custom, Competition, Chang) have made the uncertainty of market demand increased greatly after 1990s, furthermore the enterprises are facing a rapid changing and unpredictable buyer’s market, the traditional management and production pattern already unable to react to the market, it is in this circumstance, in the beginning of 1990s, American Dr. Hamor proposed management thinking “business process reengineering”, Dr. Hamor defined process reengineering as: “the fundamentally rethink and completely redesign of enterprise business process in order to improve enterprise cost, quality, service and speed significantly.” And then in the United States and other industrialized countries, made the management revolution of the “business process reengineering” (Dong 2008).

BPR emphasis on improving process and customer needs and satisfaction, the use of advanced information technology, manufacturing technology and modern management means, maximizing the technical function integration and management function integration, to break the traditional functional organization structure, building a new process of organizational structure, so as to realize the improvement of enterprise in speed, cost, service, quality and other aspects, and enhance the enterprise market reaction rate and the market adaptiveness greatly.

91.2.2 Process Reengineering Steps

Successful implementation of enterprise process engineering and establishing implementation plan is very important, the implementation is the strategic planning implementation of process reengineering. Different scholars' summarization of BPR implementation stage and stage classification are different, but the general ideas are basically the same. The key is to grasp the principle and contents of various stages (Mei and Teng 2004). The model figure of process reengineering implementation (Wang 2005) (see Fig. 91.1).

91.3 Ventilation Area Condition of a Coal Mine

91.3.1 Ventilation Area Introduction

A coal mine field area is 19.12 km^2. The product is thermal coal with low sulfur, low phosphorus, low ash and high heat. The production capacity was 2.4 million t/a in 2011. At present the mine ventilation means is the central tied and drawer-type ventilation, south well is downcast shaft, center well is return air shaft. A mine gas level is low gas mine. Safety monitoring system is KJ90 system produced by Chongqing Academy of Coal Science which can realize 24 h continuous monitoring to the factors of excavating site, such as gas, wind speed, feed state, etc. (Zhao and Zhang 2009).

91.3.2 Present Situation and Problem Analysis

A coal mine ventilation area set four work teams, 196 employees, 26 class captain, who shoulder the work of mine ventilation, safety monitoring, gas management, initiating explosive device management, comprehensive dustproof, underground fire prevention and control, etc. A coal mine ventilation area organization structure figure is as shown in Fig. 91.2. Through the methods of field inspection, related personnel's communication, special problem research and material consultation, the following key problems were found out (An and Zhang 2012).

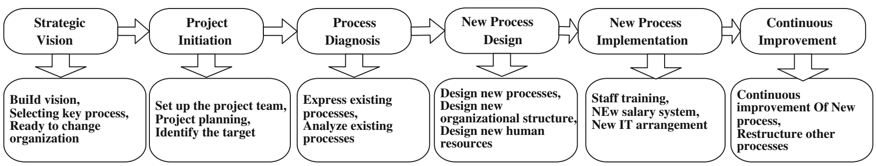

Fig. 91.1 Model figure of process reengineering implementation

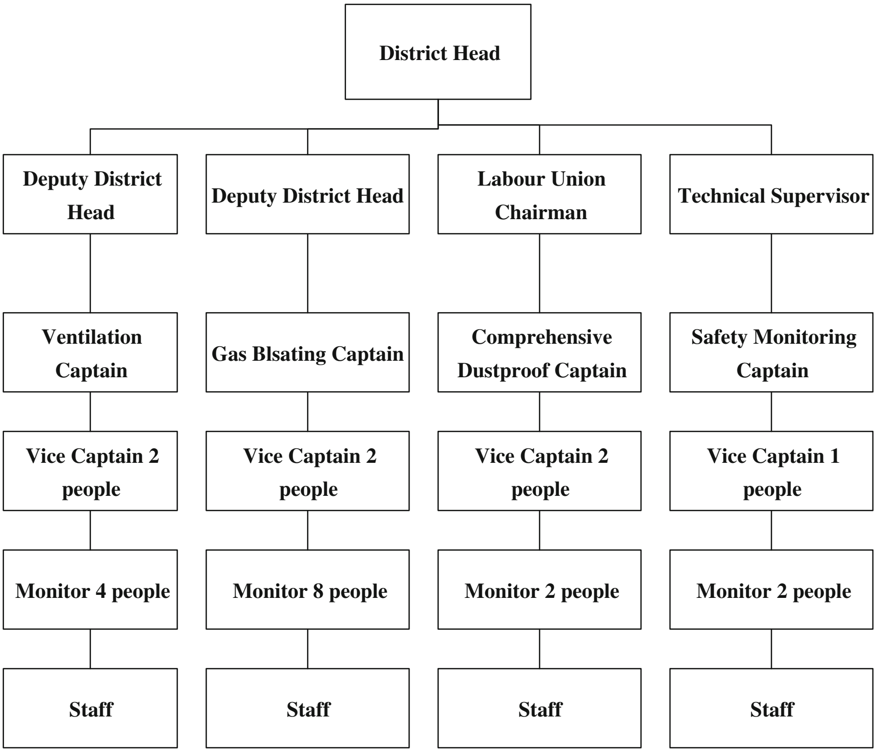

Fig. 91.2 The former organizational structure of ventilation area

1. Organization structure aspect

The organization structure of ventilation area included six layers, which lead to multiple management levels, complicated management process and difficult policies implementation; Management personnel account for 13 % of the total number of staff, management personnel is much creating human resources waste; The responsibilities of each level are not clear, not standard and unbalanced, and between departments lack of effective communication cooperation mechanism which lead to much dispute over trifles phenomenon and lower working efficiency; Assessment distribution mechanism was not reasonable, rights, responsibilities and benefits were unequal, making management personnel work more little and low positivity of staff. Such as inappropriate position of monitoring sensor on mining work face often happen shuffle disputes between safety monitoring team and tile inspection team.

2. Management process aspect

The responsibilities of ventilated process units were not clear, cooperation degree is not high, and the processes were lack of flexibility, standardization, systematization. The design and implement of Management process all existed problems, and the setting of department and key position were not reasonable and some processes often appear as "short circuit" in the implementation process, so the phenomenon of dispute over trifles and shuffle arose.

3. Human resource aspect

Ventilated area had 196 staff, college degree or above staff were 21 people, personnel quality is low which bring obstacles to the ventilation process reengineering, so we need to strengthen the technology and management training; A ventilation project often need several teams and cross work of much work which influence each other and lead not balanced work, low work efficiency, the phenomenon dispute over trifles, labor force resources waste.

4. Basic management aspect

Ventilated area basic management is weak, the existing extensive management mode seriously restricted the promotion of management and work efficiency; Class captain management is not standard, captain selection, employment, class duties, the evaluation method, standard treatment and so on were not institutionalized and standardized, not formed a set of perfect class captain management system; training work lagged behind, there widespread had the problems that heavy use, light training and heavy business technology training, light field management training.

From the above analysis, we can conclude that current business process and organization structure of ventilation area of A coal mine had been difficult to adapt to the realistic needs. Faced with such serious situation, if not decisively reform, A coal mine might face Serious safety problems soon. Although the risk of internal management changes was high, but in the present situation, the risks of no reformation would be greater than the risks of implementing reformation. Therefore, the implementation of the new process reengineering was at a better time.

91.4 Implementation of Process Reengineering on Ventilation Area

91.4.1 Principles of Process Reengineering

On the basis of the analysis of the internal and external market environment and according to the ventilation area management status, the objective of process reengineering was made sure to construct "smooth process, efficient organization, hardworking personnel" process management system (Wanbei Coal and Electricity Group Co. 2008).

91.4.2 Implementation of Process Reengineering

The management system of ventilation area after the implementation of process reengineering includes: organization setting, personnel position and title validation, functional definition, responsibilities division, management system, evaluation system, etc. (Zhu and Zang 2008).

1. Organization system design of ventilation area

Ventilation area comprises three teams, namely ventilation team, comprehensive team, gas blasting team (see Fig. 91.3).

2. Human resource positioning

According to the design of the organization and professional nature of ventilation area, and adhere to the principle of staff manning with business process optimization to targeted equipped with class and team management personnel (see Table 91.1).

3. Process optimization

According to the organization and human resource allocation of ventilation area, considering the principle of smooth process and the whole process design of A coal mine, the process of ventilation area were optimized, and the second and third process of ventilation area were designed (see Table 91.2).

91.5 Effect

From January 2011 the beginning of carrying out the above process reform plan to January 2012, through the continuous reform optimization, management people reduced by 13 %, temporary workers reduced by 30 %; organization operation

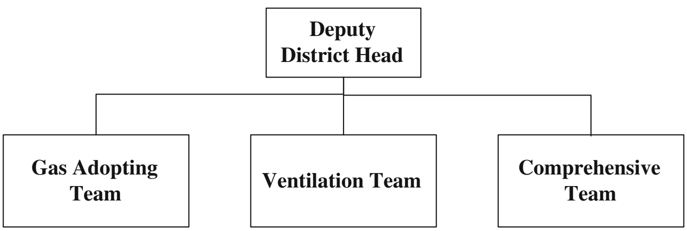

Fig. 91.3 Optimized organizational structure of ventilation area

Table 91.1 Optimized human resource positioning

Name	Position	Number	Responsibilities
Management layer	District head	1	The first person in production safety
	Deputy district head	1	Assist district head work
	Party branch secretary	1	Party affairs
	Labour union Chairman	1	Labour union work
	Technical Supervisor	1	Technical management work
Ventilation team	Captain	1	Ventilation work
	Monitor	4	
Gas blasting team	Captain	1	Gas and blasting work
	Monitor	4	
Comprehensive team	Captain	1	Dustproof, safety monitoring work
	Monitor	4	

Table 91.2 Second and third process of ventilation area

Secondary process numbers	Third process numbers	Process name
A -TF-01		Ventilation management
	A -TF-01-01	Ventilation equipment installation process
	A -TF-01-02	Construction process
	A -TF-01-03	Blind flow open process
	A -TF-01-04	Temporary wind halting process
	A -TF-01-05	Contrary wind process
A -TF-02		Gas management
	A -TF-02-01	Borehole construction process
	A -TF-02-02	Gas overrunning processing process
	A -TF-02-02	Gas drainage works management system
A -TF-03		Blasting management
	A -TF-03-01	Blasting management process
	A -TF-03-02	Explosive device management process

efficiency and production efficiency increase obviously, project construction period average reduced 3 days; product quality and customer satisfaction improved significantly. Due to the implementation of the new assessment method and salary system, the worker enthusiasm is remarkably improved, the per capita wage of worker increased by 15 %, labor productivity increased by 30 %. These show that the effect of BPR on ventilation area of A Coal Mine was obvious (Fig. 91.4).

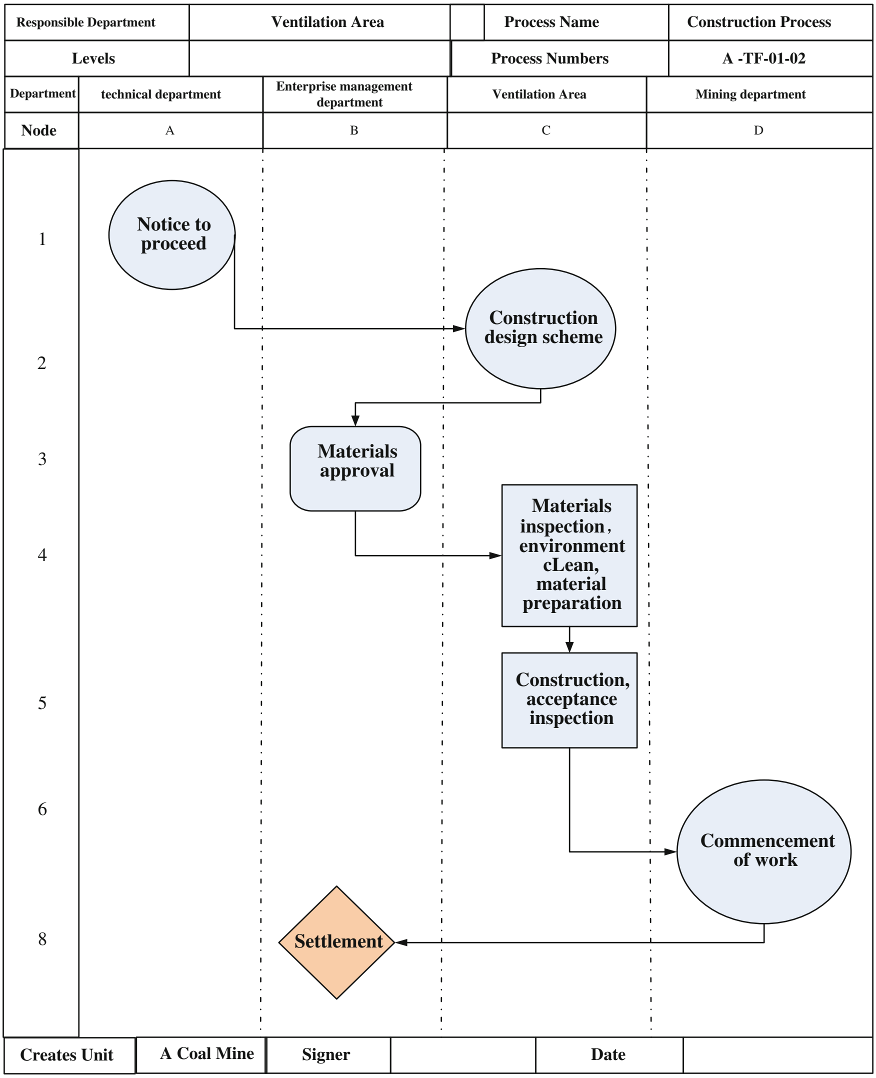

Fig. 91.4 Process figure of construction process of ventilation area

91.6 Conclusion

This paper systematically analyzed the management status of ventilation area of A Coal Mine, used the method of combining theory with practice, and put forward the implementing method to ventilation area of A Coal Mine process reengineering. Through the study, the conclusions are as follows:

1. The right process reengineering can make the enterprise operation efficiency and economic benefit, product and service quality and customer satisfaction increase hugely. Promoting process reengineering on the Mine Coal similar to A Coal Mine is the need to change development mode, can effectively standardize organization management, enhance the organization and coordination flexibility and promote efficiency and benefit (Mei and Teng 2004).
2. The practice of ventilation area of A Coal Mine process reengineering proved that the method of this paper for enterprise process reengineering has certain directive significance, and can ensure smooth completion of coal mine process reengineering (Hanuner and Champy 1993).

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Chapter 92
Study on the Estimation of Coal Washing and Processing Charges

Qing-he Yuan, Zong-qing Cui and Chao Liu

Abstract Only mastered the processing charges of the product, coal washing enterprises could make more accurate and effective cost index, then it would be possible to do product structure optimization. Based on the comprehensive consideration of the factors that affect coal washing and processing charges, the estimation methods were analyzed and adopted in this paper. In addition, the estimation model of coal washing and processing charges that based on the order was established, and then we established the estimation process and carried out the case study. In the end, a complete estimation system of coal washing and processing charges was formed.

Keywords Coal washing · Cost estimation · Estimation method · Processing charges

92.1 Significance of the Estimated

In accordance with GB 7186–7187 washed Coal terminology standards, coal washing and processing charges is defined as: In addition to the cost of raw coal, the various expenses in the coal washing costs is called coal washing and

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Q. Yuan (✉) · Z. Cui
Department of Industrial Engineering, Shandong University of Science and Technology, Qingdao, China
e-mail: Yuan_qinghe@sina.com

C. Liu
Department of Accounting, Shandong University of Science and Technology, Qingdao, China

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processing charges, and expressed in Yuan/t of raw coal (Guo 1984). Once you master the coal washing and processing charges, the true cost of coal washing products is not difficult to grasp. In turn, enterprises can develop accurate indicators of the cost of washed coal, and establish a competition mechanism dominated by the internal washed coal orders. Enterprises can also clear the cost of various varieties of washed coal operations and improve the existing cost management is lagging behind. Besides, it is conducive to explore the problem in the deep level. Companies can also shift the focus of operations to improve to service operations, and make the cost management to the longitudinal extension, so as to enhance the operating room for improvement.

92.2 The Influencing Factors and Estimation Methods of Coal Washing and Processing Charges

92.2.1 Factor Analysis of the Impact on Coal Washing and Processing Charges

In this paper, two levels below shows the factors affecting the size of coal washing and processing charges:

1. Analysis from the perspective of the composition of the coal washing and processing charges (Fu 2004).

Coal washing and processing charges refers to the various costs in the cost of coal washing enterprises, but the raw coal costs should be deducted from the cost of coal washing enterprises. Coal washing and processing charges are divided into auxiliary materials, electricity, production workers' wages, and production worker wages surcharge and so on, which is mainly determined by the coal product quality and product structure.

2. Analysis from the operating perspective.

Activity volume will affect the size of the cost. First, it needs to select different cost drivers in estimating the long-term variable costs, and appropriate cost drivers can reflect the real cost causality (Li 1995; Yali 2006). On this basis, a linear relationship makes sense. Secondly, according to the view of activity-based costing, the cost of washing and processing fees, including the sum of the costs of all aspects of service operations to complete the process experienced. Different varieties of coal washing processes will inevitably lead to all varieties of different cost.

92.2.2 The Choice of Estimation Method

When we choose the estimation method, we need to consider many factors, for example, the size of the existing cost of information content in the enterprise, the degree of accuracy of cost information required in management decision-making, in which decision-making stage, the degree of difficulty of the original data collection, etc. Appropriate choice of estimation methods makes the estimates provide more efficient management decisions.

There are many ways to estimate, and estimation can be divided into the method based on statistics and parameter fitting and analysis of estimation methods in accordance with the different estimate principle. We analyzed the characteristics of the various estimation methods by the form of a table, the specific shown in Table 92.1: For the actual situation of the coal washing business costs, product processing fees cost estimates require high accuracy and companies can provide a more comprehensive cost data. This article believes that we can estimate by combined statistical estimation method and analysis of estimation methods. First, enterprise business processes and sub varieties of coal preparation costs to the formation process should be analyzed in accordance with the requirements of the analysis estimates, which lay the foundation for the analysis of product cost. Then washing products at a variety of cost behavior analysis and processing fees were estimated by using the regression method (Zhang 2006).

Table 92.1 The comparative table of cost estimation methods

	Estimation methods	Characteristics			
		Uncertainty	Application phase	Accuracy	Information requirements
The method based on statistics and parameter fitting	Regression analysis to estimate method	Low	The early design stage	General	Less
	Similar estimation method	High			
	Functional cost method	High			
	Parameter method	Low			
	Neural network method	Medium			
Analysis of estimation methods	Activity-based cost	Low	Late design or The design is complete	Higher	The need for detailed product design information

For the actual situation of the coal washing business costs, product processing fees cost estimates require high accuracy and companies can provide a more comprehensive cost data. This article believes that we can estimate by combined statistical estimation method and analysis of estimation methods (Suo 2007). First, enterprise business processes and sub varieties of coal preparation costs to the formation process should be analyzed in accordance with the requirements of the analysis estimates, which lay the foundation for the analysis of product cost. Then washing products at a variety of cost behavior analysis and processing fees were estimated by using the regression method.

92.2.3 The Establishment of Estimation Model

Traditional cost analysis used production as a standard to distinguish between fixed costs and variable costs. In the activity-based cost, most of the indirect costs were generated by the activity. In addition, they were related to the amount of work and derived by a variety of cost drivers, while not directly linked to how much of the production and sales. Therefore, we need to combine a specific order to estimate the coal washing and processing charges.

Activity-based costing divided the operations into four types, including unit level operations, operations of the batch level, product level operations and maintenance operations, which cost is divided into three categories in accordance with the cost behavior, including short-term variable costs, long-term variable costs and fixed costs:

1. Short-term variable costs are the cost that changed in direct proportion with the product yield in the relevant range, including the costs of resources consumed by the direct materials, direct labor and unit level operations.
2. Long-term variable costs are the cost that does not change with product yield and proportionate change with products consume the operation volume in a longer period and relevant range, including the costs of resources consumed by the job of the batch level and product level operations.
3. Fixed costs are the fixed cost items that not affected by the number of foundation and the changes of activity-based cost drivers in a longer period and relevant range, including the costs of resources consumed maintenance activities (Liu 2009).

Set up a coal washing enterprises need to produce N kinds of products in order, i product yield was x_i ($i = 1 \sim N$), coal washing and processing charges are C_i ($i = 1 \sim N$).There are a total of M cost items in the existing accounting system, including L kinds of short-term variable costs, (K–L) kinds of long-term variable costs, and (M–K) kinds of fixed costs. The unit value of a short-term variable costs is b_m ($m = 1 \sim L$). The unit value of a long-term variable costs is

d_m (m = L + 1 ~ K). Corresponding to the operation volume is y_{im} (m = L + 1 ~ K). Project value of a certain fixed costs is a_m (m = K + 1 ~ M).Then the model of coal washing and processing charges for product i can be expressed as:

$$C_i = \left(\sum_{m=1}^{L} b_m \times x_i\right) + \sum_{m=L+1}^{K} (d_m \times y_{im}) + \sum_{m=K+1}^{M} a_m \tag{92.1}$$

In the formula, $\left(\sum_{m=1}^{L} b_m \times x_i\right)$ is the total of short-term variable costs, $\sum_{m=L+1}^{K} (d_m \times y_{im})$ is the total of long-term variable costs, and $\sum_{m=K+1}^{M} a_m$ is the total of fixed costs. Then coal washing and processing charges in order can be expressed as:

$$C = \sum_{i=1}^{N} C_i \tag{92.2}$$

92.3 The Basic Steps of the Coal Washing and Processing Charges Estimate

The basic steps of the coal washing and processing charges estimate can be expressed as follows:

The first step, sub-varieties of process were analyzed in connection with business process for a coal washing plant, which laid the foundation for the analyze formation process of coal washing and processing charges (Lv 2007).

The second step, combined with coal business process analysis, all the cost elements included in the company's existing accounting system need to be classified according to species, and the formation and transfer process of all varieties of products the cost of coal washing and processing charges were systematic analysis, which lay the foundation for cost behavior analysis.

The third step, the drivers of cost elements of the project were determined by regression analysis, then all cost elements of the project was divided into variable costs and fixed costs (Du 2002).

The final, the front of the establishment of the estimation model was used to estimate the fees of all varieties of products according to the behavior of the different costs. On this basis, coal washing and processing charges for certain was estimated according to the orders of enterprises. Estimate the steps shown in Fig. 92.1.

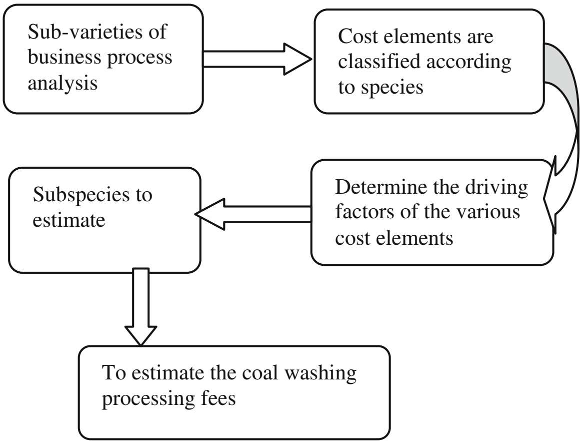


Fig. 92.1 The flow chart of processing charges estimation of coal washing products

92.4 Case Study

In this paper, a coal preparation plant as an example was adopted to illustrate the steps of the estimates of a clean coal washing fees.

According to the basic steps of the estimating, the cost elements should be analyzed when coal washing enterprise business processes are clearly defined. Based on Fig. 92.2, we can clearly see that moving sieve workshop and coal preparation workshop is related to clean coal cost workshop. We can come up with the specific cost elements of the workshop combined with the company in 2008 cost data table.

1. Moving sieve workshop: the consumption of auxiliary materials, transportation costs, the consumption of materials and consumables, repair costs, depreciation charges (Xu 2007).
2. Coal preparation workshop: the consumption of auxiliary materials. Various cost elements as shown in Table 92.2.

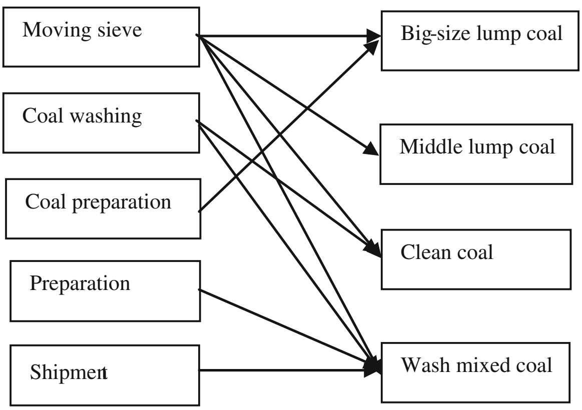


Fig. 92.2 The relation chart between workshops and products

Table 92.2 The cost items related to clean coal

Variety	Cost center	Cost elements	Driving factors	Estimation results
Clean coal	Moving sieve workshop	Production cost-raw coal-material-auxiliary materials		
		Production cost-raw coal-material-multiplexed-materials		
		Production cost-washing coal-auxiliary materials		
		Manufacturing overhead-washing coal-the other-transport charges		
		Management cost-materials and consumables		
		Management cost-repair costs		
		Depreciation charges		
	Coal washing workshop	Production cost-washing coal-auxiliary materials		
		Production cost-washing coal-housing fund		
		Manufacturing overhead-raw coal-the other-technical measures cost		
		Manufacturing overhead-raw coal-the other-water rate		
		Manufacturing overhead-raw coal-the other-transport charges		
		Manufacturing overhead-raw coal-the other-service charge		
		Manufacturing overhead-raw coal-the other-flood prevention charges		
		Management cost-repair costs		
		Depreciation charges		

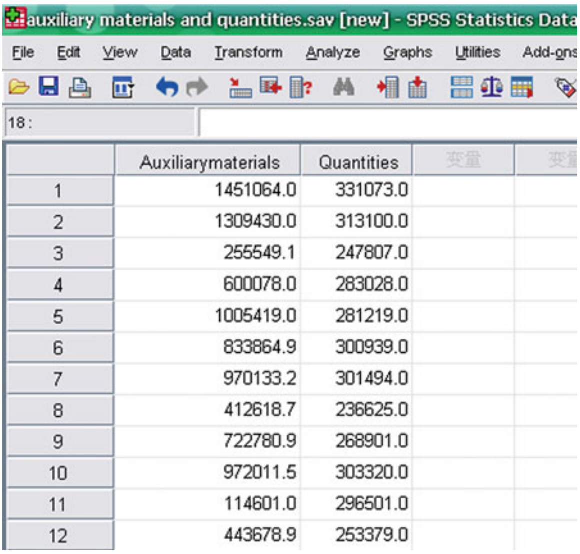
The number of cost elements and related products was examined by using SPSS software one by one in this paper. Figure 92.2 shows that: when the relationship of the behavior of the various cost elements of the moving sieve workshop was examined, its production should be the sum of the yield of these four products, including big-size lump coal, middle lump coal, and clean coal, wash mixed coal. Rest of the workshop was in the same way (Yao 2008).

Here cost elements (production cost—coal preparation—auxiliary materials) of moving sieve workshop will be an example to illustrate how we use SPSS software to looking for the drivers. And the choice of driving factor in other costs will not repeat them.

The value of cost elements (production cost—coal preparation—auxiliary materials) of moving sieve workshop and related products production was inputted the table by month to make the scatter diagram, and then we observe the relationship between the two, as shown in Figs. 92.3 and 92.4.

By the diagram above we can see that obvious linear relationship exists between the value of cost elements (production cost—coal preparation—auxiliary materials) of moving sieve workshop and related products production when November outliers was removed away (Wang 2010). Therefore, we exclude outliers and then do analysis again.

We can know the confidence level is 0.000 $<$ 0.05 by the variance analysis. So we can conclude that linear relationship between the value of cost elements (production cost—coal preparation—auxiliary materials) of moving sieve workshop and related products production is significant. In the checking table of regression equation coefficient, we can get nonstandard constant -2493700, the corresponding confidence level is 0.000 $<$ 0.05, independent variable coefficient is 11.666, the corresponding confidence level of independent variable coefficient is



	Auxiliarymaterials	Quantities
1	1451064.0	331073.0
2	1309430.0	313100.0
3	255549.1	247807.0
4	600078.0	283028.0
5	1005419.0	281219.0
6	833864.9	300939.0
7	970133.2	301494.0
8	412618.7	236625.0
9	722780.9	268901.0
10	972011.5	303320.0
11	114601.0	296501.0
12	443678.9	253379.0

Fig. 92.3 The data of auxiliary materials and quantities

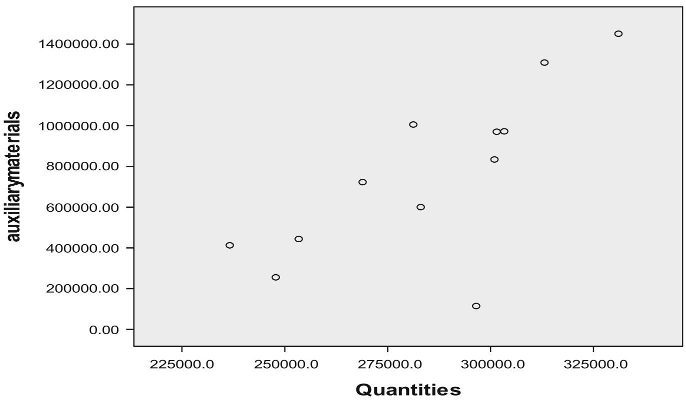


Fig. 92.4 The scatter diagram of auxiliary materials and quantities

$0.000 < 0.05$, we can think these two coefficients are significant, the linear relationship between the value of cost elements (production cost—coal preparation—auxiliary materials) of moving sieve workshop and related products production is $y = -2493705 + 11.666x$. Therefore, the driving factor of cost elements (production cost—coal preparation—auxiliary materials) of moving sieve workshop is production.

We use the labor costs of coal washing workshop as an example to illustrate how to determine the relationships between long-term variable costs and its driving factors. We know the content accounting of the coal washing workshop labor costs is the wages of workers of temporary flatcar by the field research (Kong 2009). This part of the wages of workers is a piecework nature, which is related with the number of vehicles of completed flat cars operating. Therefore, we take carriage number as the driving factors of coal washing workshop labor costs p so that linear relationship could be established.

We bring the data obtained in the previous analysis into the formula (92.1), we can get that:

$$\begin{aligned} Y =& (222.7x_1 + 213.99x_2 + 221.25x_3 + 147.26x_4) \\ & + (20\alpha_1 + 20\alpha_2) + (600\beta_1 + 500\beta_2 + 350\beta_3 \\ & + 700\beta_4 + 400\beta_5) + 9,290,307 \end{aligned}$$

In this formula, $x_1, x_2, \cdots, x_4$ represents the output of clean coal and other four kinds of major products; α_1, α_2 represents the operation volume of flat turner jobs in coal washing workshop and shipment workshop, carriage number, which take the carriage number as the unit; $\beta_1, \beta_2, \cdots, \beta_5$ represents the operation volume for transport of different modes of transport in shipment workshop, which take work shift number as the unit (Zhang 2007).

We put product yield in the order and the number of operations consumption required to complete the orders into the formula that was got in the previous step, then coal washing and processing charges to complete the order could be obtained at 31.73 Yuan/ton.

92.5 Conclusion

This article was primarily based on the Cost Estimating System of coal washing and processing charges in coal washing enterprises. Using the analysis of the estimation method and statistical estimation method were combined to estimate coal washing and processing charges by comparative analysis of the estimation method. This principle of the method is simple and easy to operate, which comply with the requirements of the coal enterprises in the cost estimate (Yi 2010). In addition, the influencing factors of the coal washing and processing charges were analyzed from two different angles that cost structure and operating, and estimated mathematical model was established. In the end, the cost was estimated by combining with specific business.

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Chapter 93
College Moral Education Decision System Designing Based on Web Mining

Ying Xi

Abstract As the technologies of data mining evolving, web mining has been taken into many aspects of society research. Unfortunately, only a few of them concern moral education. To facilitate the moral education decision making, we propose a model of college moral education decision system to provide a general solution. Based on the remote education technologies and traditional moral education management methods, we track the students' dynamic experience information using web mining technologies and extract the knowledge for decision making by association rules mining. With the help of our system model college moral education decision making could be done in a more efficient and effective way.

Keywords Association rules mining · Experience information tracking · Moral education decision · Web mining

93.1 Introduction

In recent years data mining has become more and more important in many fields (Jensen and Neville 2003; Hirschman et al. 2002; Witten and Frank 1999; Durkheim 1961). Unfortunately, only a few of them concern moral education (Luan 2002). Massive data obtained from college students are multi-dimensional, incomplete, noisy and obscure. In order to detect the defects of moral education for each student and make the education more effective, the predominant question is *how to extract the implicit but meaningful knowledge for making moral education decisions*. Thus, there is a strong motivation to design a decision system covering all the aspects of moral education.

Y. Xi (✉)
School of Humanities, Economics and Law, Northwestern Polytechnical University, Xi'an, China
e-mail: xiying822@mail.nwpu.edu.cn

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The principal contribution of this paper is the introduction of a model of college moral education decision system which is useful to data administrators and analyzers. The left parts of the paper are organized as following: Sect. 93.2 is about the architecture and components details of the model; Sect. 93.3 shows the kernel of the analysis component. Section 93.4 is our implementation of the model. Section 93.5 evaluates the model and concludes the paper.

93.2 College Moral Education Decision System Architecture

In this section we describe the desired properties of a system designed for education decision making and our design to achieve all the properties.

93.2.1 Desired Properties

Global data. In order to make the moral education strategy effective, we need to profile each student from many aspects. Unfortunately, they've been stored by several departments separately. Hence there could be several different data schemas in various environments. Many applications run on their own data sources independently. After integrating them into a larger one, the original data source should be still kept without dependence.

Timely updating. The data sources from every department are not static. They're changing over time. With many recruits entering and graduates leaving, there could be lots of "insert" and "delete" operations. And when a student's information changed, each data source will modify their counterparts. The decisions depend on these records should follow all the updates in time.

Knowledge extraction. This is the kernel of the moral education decision system. The effectiveness of the final moral education strategies largely depends on this part. By tracking the students' experience information, several association rules are expected to help students' action explanation and prediction.

Expressive interface. The users of the system need to access the data through an expressive interface. Hence, the results should be explained in perceptual ways.

93.2.2 Architecture

We design the moral education decision system to fulfill the requirements above by following (see Fig. 93.1):

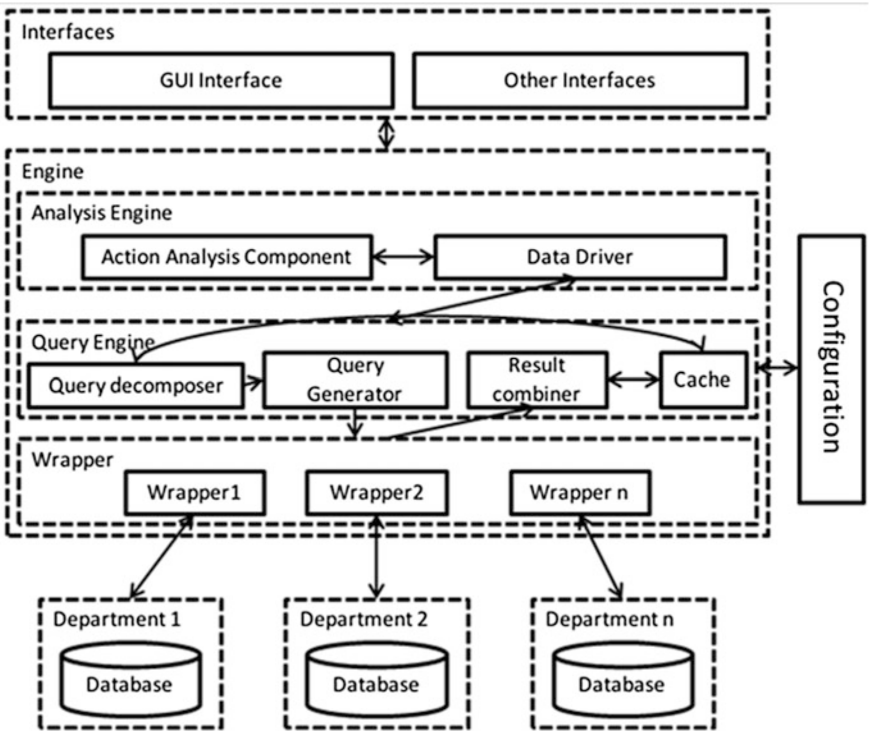

Fig. 1 The architecture of moral education decision system

1. Wrapper

Each data source has a data wrapper of its own. The wrappers contact with data sources directly. They pump the data from their sources and wrap them into a general schema. When a query coming, the wrapper executes it, and returns the query results. Considering the extension of the data sources, the wrappers do all the tasks as plug-ins (Barbosa et al. 2002; Halevy et al. 2006).

2. Query Engine

The query engine uses a SQL-like data definition and manipulation language.

- Data sources mapping: **Set** *database name. table name* **as** *alias*. For example: **Set** *db1.table1* **as** *a1*, *db2.table2* **as** *a2*.
- Query statement: **Select** *a1.name, a2.score* **From** *a1*, *a2*, **Where** $a1.id = a2.id$, and $a1.age > 20$.

After a query submitted, the query decomposer checks the syntax first, and starts to decompose the query if it has passed.

Here are some decomposition principles:

- Make the queries which operate among several databases into queries on a single data base.
- Do the queries which contain the most conditions first.
- If the results contain the properties needed to be shown, put the results into cache and reconstruct the query on a single database.
- If the cache is not empty, find the data in the cache according to the final query requirement and integrate all the data.

According to the query statement above: **Set** *db1.table1* **as** *a1*, *db2.table 2* **as** *a2*; **Select** *a1.name*, *a2.score* **From** *a1, a2* **Where** *a1.id* = *a2.id* and *a1.age* > 20.

- We first decompose the query into two single-database queries. **Select** *name,id* **from** *table1* **Where** *a1.age > 20* **order by** *id* **on** *db1;* **Select** *score, id* **from** *table2* **order by** *id* **on** *db2*.
- Then we send the query, "**Select** *name,id* **from** *table1* **Where** *a1.age > 20″* to the corresponding wrapper and do the query and the wrapper returns the results. Because the results contain the final visual properties, we put them into cache and construct the new query statement: "**Select** *score, id* **from** *table 2* **where** *id* **in** *(id results)*".
- In the final step, we compare the results from step 2 and the results in the cache, and output the final results combined by the result combiner.

3. Analysis Engine

Data driver is a driver used to interact with the query engine. It contains several wrapped functions. Hence, the real analysis part could get their needed data in a simple way. The action analysis component is the kernel of the analysis engine. It explores the association rules from the whole data sources. The details of this component are discussed in the following section.

93.3 Moral Education Association Rules Mining

93.3.1 Definitions and Problem Description

The formal descriptions of association rules are as following (Han and Kamber 2001)[1]:

Suppose $\mathrm{I} = \{\mathrm{i}_1, \mathrm{i}_2, \ldots, \mathrm{i}_\mathrm{m}\}$ is a set of commodity items in the trade database. Each transaction T is a group of commodities. Obviously, $\mathrm{T} \subseteq \mathrm{I}$, each transaction has a unique identifier called TID. If the item set $\mathrm{X} \subseteq \mathrm{T}$, we say that the transaction T supports X, or T contains X. Association rules are such kind of implications: $\mathrm{X} \rightarrow \mathrm{Y}$, in which $\mathrm{X} \subseteq \mathrm{I}, \mathrm{Y} \subseteq Y$, and $\mathrm{X} \cap \mathrm{Y} = \phi$ If there are s % of transactions support X, it claims that the support of X is s, i.e. Prob(X) = s% , written as support(X) = s. If there are c % of transactions, which support X, also support Y, we say that the confidence of rule $X \rightarrow Y$ is c, i.e. prob(Y|X) = c% . If the item set X has a greater support than the user predefined, X is a frequent item set. Usually, users have to determine the minimum support and the minimum confidence according to the mining.

The problem of association rules mining is: given a transaction database, find all the association rules that has greater support and confidence than the predefined ones.

93.3.2 Association Rules Mining Algorithm

In 1993, Agrawal designed an algorithm based on two-phase frequent set (Agrawal et al. 1993). It divides the mining algorithm into two sub-problems:

- Find all the item sets which have greater support than the minimum support;
- Use the results obtained from the 1st step, for each frequent set A, find all the non-empty sets a. If support (A)/support (a) $\geq$ minconfidence, then generate the rule: $a \rightarrow A$.

In the moral education decision system, to find the associations among the actions we apply the algorithm on the students' experience information. There are two different strategies. One is to find the root of the actions. The other is to predict the possible actions. In our application, we treat the properties as items and their modifications of the same record in a specified period as a transaction. The algorithm is shown in Table 93.1.

93.4 Implement of the Moral Education Decision System

We implement the moral education decision system as a demo in C# based on.NET Framework 4.0. The main GUI is shown in Fig. 93.2. With the help of our system, the moral education could be done in a simpler way. By the results of association rules mining, we can make the education more exactly. For example, we find that if student A is a shy boy, the possibility of conflicting with others is little. But he may feel more pressure. If student A is a shy girl, the possibility of melancholia is greater than a shy boy (Weng et al. 2002).

Table 1 Association rules mining in the moral education decision system

Input: students' property set, transactions of properties

Output: properties' association rules set $\cup_k L_k$

```
begin
L_1={large 1 property set}
for (k = 2; L_{k-1}=ψ ; k = k + 1)
        C_k = apriori-gen(L_{k-1});
        for each transaction t∈ D
           C_t = subset (C_k, t);
           for each candidate c∈C_t
              c.count = c.count + 1 / |D|;
           end for
        end for
L_k = {c∈C_k| c.count ≥ minsup};
end for
end
Function C_k apriori-gen(L_{k-1})
begin
Find all the candidates and insert it into C_k;
for each item set c∈C_k
    for each (k – 1) subset s of c
        if (s∈ L_{k-1}) then
           delete c from C_k;
        end if
    end for
end for
end
```

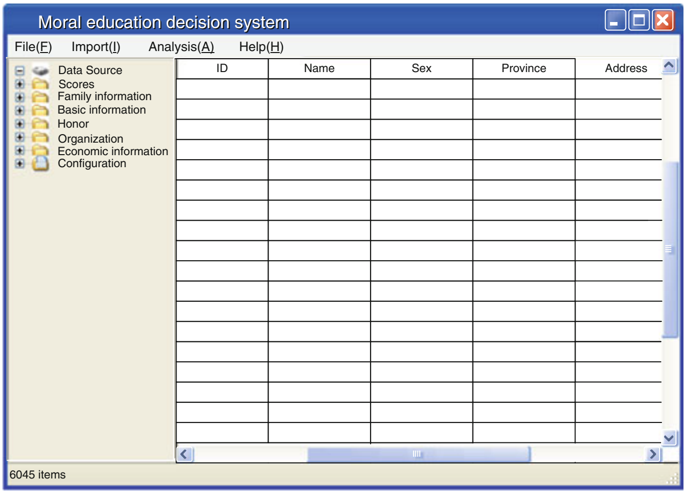

Fig. 2 UI of the moral education decision system

93.5 Conclusion

Data mining technologies have been used in the education only for less than four years. The abilities of prediction, associations mining, clustering, and etc. make it take more and more effects. In this paper we design a moral education decision system based on the association rules mining. With the help of many other technologies we'll add several other functions to make the moral education more efficient and effective.

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Chapter 94
KPI-Based Private Enterprise Staff Performance Index Design

Ya-dong Wang and Yu-ling Hao

Abstract Private Enterprise Employee Performance Evaluation Index System design is the core of private enterprise performance management issues, performance appraisal Index to scientific and reasonable not only help improve individual performance of employees of private enterprises and private enterprises contribute to the strategic objectives. This paper describes the basic theory of KPI, based on the employees of private enterprises is proposed KPI performance index based on design ideas and methods, and finally to private enterprise KPI system in a typical application cases are analyzed and studied.

Keywords AHP · Key performance indicators · Performance management · Private enterprise

94.1 Introduction

Along with the rapid economic development, competition among non-public enterprises has become even fiercer, the research non-public enterprise with typical Chinese characteristics performance increasingly receive attention. Performance management is a quite important link of the human resource management, and it is a kind of activity that can ensure the goals of enterprises are achieved in an effective and efficient manner. The need to devise the most suitable for the enterprise performance management mode, which can be intense competition to survive and develop, and this is one point for non-public enterprises to have more urgent and practical significance (de Menezes et al. 2010).

Y. Wang (✉)
University of Science and Technology Liaoning, Anshan, Liaoning, China
e-mail: qygl1234@126.com

Y. Hao
The Open University of Harbin, Harbin, Heilongjiang, China

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94.2 KPI Meaning

Key performance indicators (Key Performance Indicator) referred to as the KPI is an advanced strategic performance management tools (Tabassi and Abu Bakar 2009). KPI is used for assessment and manage the performance appraisal are quantifiable or capable of acts of the standard system; is able to reflect the added value of organizational goals of performance indicators; through the commitment of key performance indicators, staff and management staff on work can be expected, performance and future development of the communication. A system designed to highlight scientific and deliver KPI’s strategic intent and strategic business focus on the work of the staff have a strong traction, through the effective implementation of the KPI system, companies can achieve the desired level of performance, to achieve the desired business objectives.

94.3 KPI Basic Principles of Design

94.3.1 Strategic Orientation Principles

KPI can only come from the corporate strategy, and must be able to effectively support the strategic objectives. KPI staff must produce the correct behavior of traction, so that employees can contribute to the success of enterprises. When the company’s strategic shift occurred when, KPI should be timely adjusted to reflect the strategic shift to employees after the new requirements.

94.3.2 Operational Principles

KPI must have a clear definition and calculation methods, and easy to obtain reliable and impartial data. In other words, KPI must be measurable. KPI can be measured, there are two criteria, the first is quantifiable, and the second is with the behavior described. They meet one of the two, can be measured.

94.3.3 The Sensitivity of Principle

KPI should be able to distinguish between objects of different performance evaluation of different levels and different, to distinguish good and bad results of the work of different individuals, the level of performance. If the index can not be distinguished, each individual all have the same results of the evaluation, this indicator can not be used as KPI.

94.3.4 The Principle of Refining

KPI is to achieve the strategic objectives of the key performance factors to measure, so the number of KPI should not be too much. KPI design should be simple, refined, to the reasonable control of the number of KPI's to highlight the key, to avoid excessive refinement and generalization of KPI.

94.3.5 Controllability Principle

KPI in the design of enterprise, the employee must pay attention to key performance indicators should be reached with considerable control. KPI set should be within the purview of my staff to control issues. Consider whether the staff should be fully able to control the outcome of the index, if staff can not control, then the index can not be used as key performance indicators.

94.3.6 The Principle of Controlling the Input and Output

Design KPI should give priority to process the input and output conditions, the process between the two closely linked as a whole, for effective process control (Melo et al. 2010; Buller and McEvoy 2012; Stanna et al. 2012).

94.4 Employees Based on Private Enterprise KPI

To develop enterprise-level KPI. First, a clear corporate strategy to the general use of "fish bone diagram" approach to corporate strategy to break it down, and then extracted, summarized to identify the critical success factors of enterprises.

The development of sector-level KPI. KPI development of enterprise-class, the various departments in the enterprise-level KPI's based on the functions of the departments and the business processes were developed in this department KPI.

To develop employee personal KPI. KPI similar with the department, the staff also based on their individual KPI's KPI and staff in the department's job responsibilities and business processes to develop.

Design performance appraisal criteria. Key performance indicators is to work from what to measure, and performance evaluation criteria is to be assessing the various indicators in the level should be achieved.

Review of KPI system. Review of key performance indicators. The main purpose is to confirm whether these key performance indicators comprehensive and objective evaluations of those responses are performance and suitability to operate, so as to reset the performance test (Lengnick-Hall et al. 2009).

94.5 KPI System Analysis of the Advantages and Disadvantages

94.5.1 Advantages

The strategic objectives of the enterprise down to every level, so that their strategic goals can be precise, very level implementation of the enterprise at all levels to help achieve corporate strategic objectives; benefit managers always pay attention to the important factors affecting their performance timely detection of problems and response measures in advance; beneficial interests and personal interests organizations agreed to form within the enterprise for the common goal of the polymerization of the situation (Tohidi 2011; Foley et al. 2012; Aguinis et al. 2011).

94.5.2 Disadvantages

There is no clear, with operational and effective process to develop key performance indicators and critical success factors of different companies is not the same, it is more difficult to determine the key performance indicators; KPI key performance indicators tend to more quantitative methods indicators, excessive reliance on these indicators, do not take into account factors that may create unnecessary flexibility disputes and objections (Taylor 2007; Ganzach 2006).

94.6 Empirical Analysis

94.6.1 Introduction

A company is high-tech machinery and equipment manufacturing machinery manufacturing-based private enterprises, more than 1,000 employees, the company's senior realizes that to achieve the sales target this year to maintain sustained and rapid development of the company, improve employee performance is very necessary, so the company began building A employee performance management system. Including performance management system is a performance plan, performance implementation, performance feedback, performance improvement cycle of the complete system, and indicators of performance appraisal performance management system designed to run directly affect the success or failure, so the design performance management performance index is the key to system.

94.6.2 A Company Based on KPI's Design Performance Index

1. decomposition of strategic objectives, identify enterprise-level KPI A company's strategic objectives in 2011 to keep the company in the context of sustainable development high-speed sales of 3 billion, the company's strategic goal of "fishbone diagram" method decomposition, as shown in Fig. 94.1. Decomposition according to the company strategic objectives, the company's enterprise-class was A KPI Table 94.1.

2. development of sector-level KPI (in marketing for example) A company based on enterprise-level KPI, job duties with marketing department to develop marketing KPI as shown in Fig. 94.2.

3. the same way with the departments KPI development, development of individual employees KPI, performance assessment indicators and then determine the performance appraisal criteria Jibei assessment indicators in the various levels should be achieved, and finally determine the performance measure based on the principles established by the Audit performance index can comprehensively and objectively reflect the performance of those being assessment.

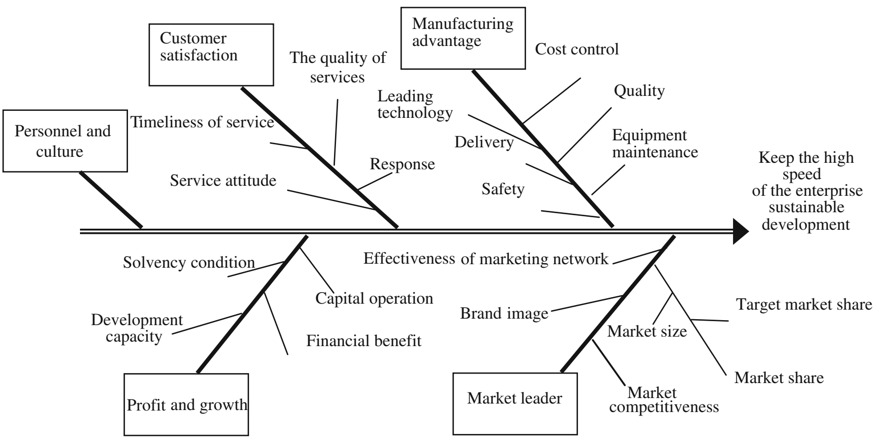

Fig. 94.1 A company's strategic goal of *fishbone diagram* method decomposition

Table 94.1 A company enterprise-level KPI

Key business areas	Enterprise-level KPI			
Market leader JMG	Market share	Effectiveness of marketing network	Brand image	–
Manufacturing advantage	Quality	Cost control	Delivery	Leading technology
Profit and growth	Financial benefit	Capital operation	Solvency condition	Development capacity
Personnel and culture	The quality of the staff	Employee satisfaction	Excellent enterprise culture	–
Customer satisfaction	The quality of services	Timeliness of service	Response	–

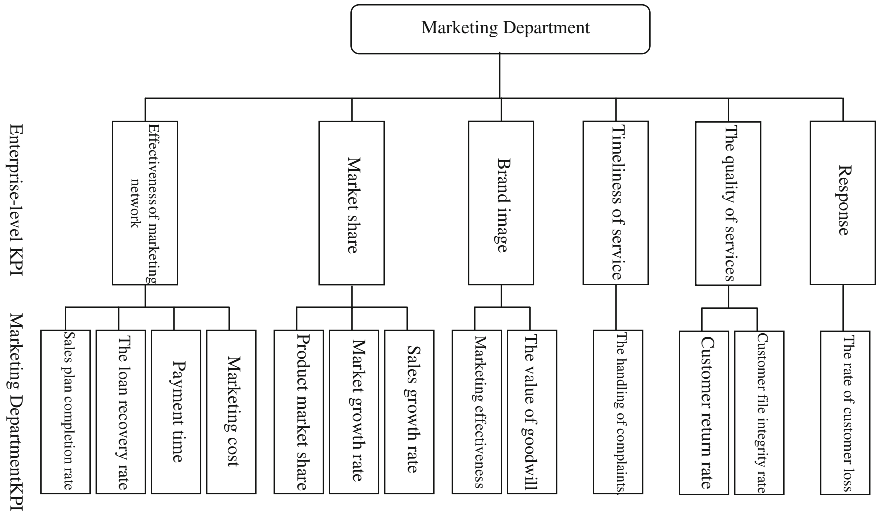

Fig. 94.2 Based on the enterprise KPI of market department KPI

94.6.3 The Performance Index to Determine the Weight (In a KPI Enterprise Marketing Department for Example) AHP to Determine Weights of Each Performance Measure, Follow These Steps

1. the establishment of hierarchy model

   The marketing performance evaluation index system.

2. matrix structure

Using pairwise comparison method to quantify the marketing department of the A KPI Enterprise judge the relative importance of Table 94.2, comparison matrix structure accordingly.

3. calculate the weights

Calculated to determine the largest eigenvalue matrix $\lambda_{\max} = 6.1971$. Eigenvector corresponding

WT = (0.1998, 0.2138, 0.1761, 0.0433, 0.0873, 0.2796), A is the enterprise-class marketing department KPI's weight.

4. consistency test

Matrix A, in determining the possible inconsistency in judging, hence the need for consistency test. To test the consistency of Judgement, you need to calculate the consistency index CI, the average random consistency index RI and the random consistency ratio CR. $CI = (\lambda_{\max} - n)/(n - 1) = 0.03942$

It should be noted that when the $\lambda_{\max} = n$, $CI = 0$, is exactly the same; CI higher the value, the worse the consistency of comparison matrix in general as long as the $CI \leq 0.1$, the consistency of comparison matrix can be considered acceptable, otherwise Zhongxin structure to determine pairwise comparison matrix.

RI values can be based on the order of the matrix in Table 94.3 from Richard.

$$CR = CI/RI = 0.3942/1.24 = 0.0318$$

General random consistency ratio CR is less than 0.1, can be considered satisfactory to determine the consistency matrix, the weight vector and reliable. The consistency test, the marketing department of the A KPI that is enterprise-class brand, response, effectiveness of marketing network, on-time performance, quality of service assigned to 0.1998,0.2138,0.1761,0.0433, 0.0873, 0.2796 weight more reasonable.

Table 94.2 A company marketing enterprise to quantify the relative importance of KPI results

	Brand image	Response	Market share of	Effectiveness of marketing network	Timeliness of service	The quality of services
Brand image	1	1	1	4	2	1
Response	1	1	2	4	3	1/2
Market share	1	1/2	1	5	3	1/2
Effectiveness of marketing network	1/4	1/4	1/5	1	1/3	1/5
Timeliness of service	1/2	1/3	1/3	3	1	1/3
The quality of services	1	2	2	5	3	1

Table 94.3 1–9 Order to determine the average random consistency index matrix

n	1	2	3	4	5	6	7	8	9
RI	0.00	0.00	0.58	0.90	1.12	1.24	1.32	1.41	1.45

94.7 KPI's Based on Private Enterprise Employees in the Performance Evaluation Index System Design Should Pay Attention to the Problem

94.7.1 A Clear Business Strategic

KPI-based private enterprise staff performance index design is the first step, companies should define their development strategy. Private enterprises due to their own conditions, corporate strategic planning in the obvious deficiencies still exist, and some companies do not even have strategic planning, therefore, private enterprises must develop clear strategic goals and corporate vision.

94.7.2 Focus on Two-Way Communication

Private enterprise key performance index design is the focus of corporate strategy will be implemented by every level for the key performance indicators of individual employees, individual employees are the key actions to achieve business strategy, so the key performance index in the design process, to focus on two-way communication with staff to improve employee performance evaluation of key indicators of identity, is conducive to the improvement of individual performance and corporate strategic objectives.

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Chapter 95
Measuring the Sharing Effect of Tacit Knowledge Based on Structural Holes Theory: Case Study on a Military Enterprise

Li-ping Shi, Shu-lin Tang, Qiang Liu and Jing-ting Yuan

Abstract Because employees turnover, Military enterprises need restored timely the social networks of information transmission network. Therefore, making the social networks comply with the sharing demands, reducing knowledge losses associated with destruction of the social networks, and providing the most suitable person for the social networks have been becoming main problems of the military enterprise reform. This article proposes a quantitative method using social network structure (network density, structure hole and network centricity) and social network interactive (exchange frequency, close degree and contact strength) as measure indicators to measure the influence of each members sharing with the tacit knowledge. Finally, the article suggests that the person with the similar social function was filled up the vacant job.

Keywords Tacit knowledge · Knowledge sharing · Social networks · Structural hole · Military enterprise

95.1 Introduction

In the intellectual and economical epoch, the military enterprise should be an intellectual enterprise with innovation ability. Knowledge-based enterprise capacity consists of two parts: military enterprises have a static stock of knowledge and can promote the ability of knowledge sharing and transferring. At present, military enterprises by constantly improving workflow and applying e-enterprise information systems have realized the exchange and sharing of explicit knowledge in a static stock of knowledge of the military enterprises and also have improved the knowledge application and work efficiency. However, because of knowledge

L. Shi · S. Tang (✉) · Q. Liu · J. Yuan
School of Economics and Management, Harbin Engineering University, Harbin, China
e-mail: tangshulin00.student@sina.com

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inertia and internal viscous, the military enterprise's tacit knowledge flowing is not smooth as imagined. Practice shows that only 10 % of the knowledge in an organization is explicit while the other 90 % of the knowledge is tacit (Bartlett 2003). From the perspective of the development speed of the stock of knowledge and core competencies, if tacit knowledge is effective only in the individual range, the ability of intellectual government will be greatly reduced. Therefore, promoting the sharing of tacit knowledge effectively has important implications for enhancing the ability of the Government's implementation of government.

95.2 Literature Review

Now, the research focused on how to measure the tacit knowledge of the military enterprises. For military enterprises, it has to research the tacit knowledge sharing between the members of organizations, and meanwhile, focus on military enterprise's tacit knowledge sharing between the social networks. Based on the comparative analysis of tacit knowledge sharing in the several military enterprises and financial and banking institutions of Australia, Moran (2005) thought that the tacit knowledge of the enterprises should adopt the sharing way of rule by man, while the financial and banking institutions should adopt the sharing way of system-oriented. Wang and Xi (2009) found that members of the enterprises thought the tacit knowledge sharing in the military enterprises was an additional task, they had an inimical emotion for establishing the tacit knowledge sharing, this conclusion implied that managers should eliminate the inimical emotion of the civil servant, and had better use the non-task mode—social relationships to implement the tacit knowledge sharing before establishing a normal regulation and an organizational culture.

Kapucu (2006) conducted a study on knowledge sharing in the project organization, obtained the impact of network density on the sharing of knowledge in the team level and the strong links, network size and structural holes on a personal level. Berta and Baker (2004) thought that communications between acquaintances or friends in the product developing networks could enhance the probability in designing the front-end products. Churchill and Halverson (2005) used the social network theory and the organizational theory to explore the main changes of three major telecommunication companies, and he found that when dominated by explicit knowledge in the enterprise, the weak joint in social networks played a crucial role, while the strong joint played an important role in the tacit knowledge dominated.

The literature review shows that there are obvious differences between the characteristics of individual tacit knowledge in government departments and other organizations. The main contribution of this paper is to explore the effect mechanisms of social networks with the intellectual government's tacit knowledge sharing, and provide an effect measure method of the intellectual government's tacit knowledge sharing based on the structural holes.

95.3 Methodology

95.3.1 Connotation of the Tacit Knowledge in Knowledge-Based Military Enterprises

The military enterprise's tacit knowledge refers to the knowledge that only appears in the specific contexts and relationships which are owned by the management team, staffs, the experts hired by the enterprise. It is reflected in the skill, technique, knack, experience, insight, mind mode, the tacit understanding of the group members and some knowledge which is difficult to accurately describe by language (Suh 2002; Kijkuit and van den Ende 2008). The military enterprise's organized tacit knowledge mainly exists in the organization principle, practice, convention, structure and the organization's experience, vision, objectives and the organizational relationships.

At present, major problems of sharing the military enterprise's tacit knowledge are as follows: the staffs don't know they have the tacit knowledge; don't know how to share it and whom to share with, or believe that sharing knowledge is a waste of time; the military enterprises would not share knowledge in a hierarchy team or a power unbalanced organizations (Bock and Kim 2002); superiors influence the communication of the people; because of the complexity of the military enterprise organizational structure and movement of personnel, a lot of the tacit knowledge disappears with employees turnover and is not well inherited and preserved; social problems become more and more complex, the complexity of different kinds of business requires the staff have the ability to update their knowledge system quickly (Bock et al. 2005); the professional researchers may not be familiar with the actual problems in the business site and therefore unable to provide valuable knowledge or information to military enterprises (Ignacio et al. 2009; Byosiere et al. 2010).

Social networks of sharing the tacit knowledge are constituted by the enterprise organization structure, the position of the each individual in social networks, and the strength of the links of individuals in social networks. The military enterprise's organization structure refers to the density of social networks, which reflects in the order of different parts in the military enterprise, space and position, state of aggregation, contact information and the relationships between the essential elements as a model, and it is an important part of the military enterprise's administrative system. Military enterprise organization is a typical hierarchical structure, as well as a kind of sparse social networks in which some members of the network will be quarantined, or formed independent factions to reduce the effect of tacit knowledge sharing, which is called "structural hole".

The strength of the links refers to the communication frequency and depth between government members and other members. The location of the joint determines the connection strength of the social networks, high communication frequency and depth is called the "strong connection" and "weak connection" vice versa. Strong connections make people produce the same vision and action and have a stronger executive power, but the degree of the redundancy in tacit knowledge is higher and needs higher cost to maintain, the individuals require much time and energy to sustain the existence of strong connection. Weak connections bring the non-redundant knowledge to government departments, and promote “elastic thinking”, which can lead to more innovations and discoveries and maintain the lower cost.

95.3.2 Structural Constraint Algorithm of Government Tacit Knowledge Sharing Effect Measure

According to the data of the behavioral investigation questionnaire, this thesis uses the structural constraint algorithm to analyze the investigation result with the social network analysis, and calculates it with the network constraint coefficient for the network closure and structural holes of government tacit knowledge sharing; this coefficient refers to the affinity that a certain node links directly or indirectly with other nodes in the network, which is used for explaining individual’s influence degree on the whole network. The calculation procedure is: (Wang 2008; Wan 2011; Yang 2007)

Step 1, calculate the constraint of node i linking with node j;

$$CI_{ij} = (P_{ij} + \sum_{q} P_{iq}P_{qj}) \tag{95.1}$$

Step 2, calculate the network constraint coefficient of node i;

$$CI_i = \sum_{j} CI_{ij} \tag{95.2}$$

Step 3, calculate the network effective scale.

The calculation formula is:

$$\sum_{j}\left[1 - \sum_{q}^{n} p_{iq}m_{jq}\right] \tag{95.3}$$

Among them, j indicates the entire node that linking to node i, and q is third except node i and node j. $p_{iq}m_{jq}$ is the redundant linking number of the individual i and node j.

Step 4, calculate the hierarchy.

Hierarchy reflects the constraint that the node i afford from the neighboring node comes from the degree of the individual node, if the value is smaller, it indicates the constraint is from the centralized pressure of a certain node; on the contrary, it indicates that the constraint is from the average pressure of the node. The calculation formula of the hierarchy is:

$$H_i = \frac{\sum_j \left(\frac{CI_{ij}}{CI_i/N}\right) \ln\left(\frac{CI_{ij}}{CI_i/N}\right)}{N \ln(N)} \tag{95.4}$$

Step 5, calculate the betweenness centrality.

Betweenness centrality is the algorithm used to estimate the degree of individuals controlling the tacit knowledge, the data range of betweenness centrality is between 0 and 1. The calculation procedure is.

1. Calculate the communicating capacity of point x_i controlling x_j, x_k;

$$b_{jk}(x_i) = \frac{g_{jk}(x_i)}{g_{jk}} \tag{95.5}$$

2. Sum up the entire node that passing point x_i;

$$C_B(x_i) = \sum_{j<k}^{n} \sum_{j<k}^{n} b_{jk}(x_i)(j<k\ i \neq j\ i \neq k) \tag{95.6}$$

calculate the relative betweenness centrality of point x_i;

$$C'_B(x_i) = \frac{2C_B(x_i)}{n^2 - 3n + 2} \tag{95.7}$$

95.4 Results

95.4.1 Sample Selection and Data Collection

This article takes 65 samples from Hafei Motor Co.,Ltd. (Heilongjiang Province, China) as survey targets. These individual samples are randomly selected and are asked to honestly fill in a questionnaire.

95.4.2 Data Processing

Returned questionnaires will be anonymous counted, and handling out 65 with 57 returned. The community graph of tacit knowledge sharing is produced according to the research findings (See Fig. 95.1).

The results are shown in Table 95.1, by using the software to measure two network structure indices of structural constraint and betweenness centrality of the community graph, and merging the two measuring values.

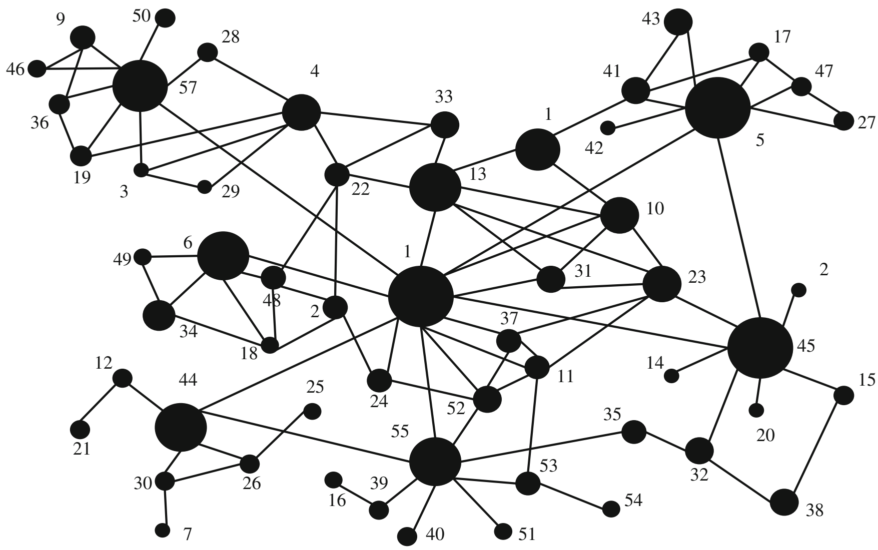


Fig. 95.1 Community graph of tacit knowledge sharing

Table 95.1 Partial results of structural holes and the central index of government tacit knowledge sharing in social networks

	Degree	EffSiz	Effici	Constr	Hierar	Detwee	nDetwee
1	13.000	11.615	0.893	0.131	0.030	434.434	0.2821
57	8.000	7.250	0.906	0.223	0.065	145.992	0.0948
50	8.000	7.750	0.969	0.132	0.002	126.434	0.0821
56	7.000	6.714	0.959	0.155	0.005	121.506	0.0789
7	8.000	6.750	0.844	0.250	0.047	119.658	0.0777
45	4.000	3.500	0.875	0.334	0.024	108.416	0.0704
8	5.000	3.800	0.760	0.396	0.042	74.536	0.0484
14	6.000	4.333	0.722	0.310	0.016	54.054	0.0351
6	5.000	4.600	0.920	0.249	0.019	34.496	0.0224
31	4.000	3.500	0.875	0.334	0.024	32.186	0.0209

95.5 Discussion

95.5.1 Data Analysis of Behavioral Science

42.11 % of the military enterprise staffs are a little bit familiar with their tacit knowledge. 8.77 % of the military enterprise staffs are well aware of their own tacit knowledge. Generally speaking, more than half of the military enterprise staffs understand their own tacit knowledge which necessary condition of the military enterprise to implement tacit knowledge sharing and fill in the tacit knowledge vacancy caused by employee turnover. For understanding other members' tacit knowledge, 36.84 % of people don't understand very well, and 26.32 % of people don't understand. The results show that the military enterprise has a very obvious authority limit. Individuals are only responsible for their own affairs, while don't know much about the tacit knowledge of other persons or organizations, which is the basic reason of the collaboration inefficiency in this military enterprise. Therefore, the military enterprise reform should focus on the collaboration during the business, and promote the overall tacit knowledge sharing. The majority of military enterprise staffs (73.68 %) believe that experience can stimulate their tacit knowledge, while expertise (59.65 %).

The research shows that the sharing ways, the convenience of communication, the coupling strength, the degree of purpose unity, and policy guidance can effectively increase the communication frequency of the organization, while the task-oriented, the certainty of responsibility, the average age and other factors can reduce the organization communication frequency. 52.63 % of people, owing to the working needs, share the tacit knowledge with other people, 21.05 % of people want to exchange the tacit knowledge with others. It proves that the motivation of the tacit knowledge sharing between members of the military enterprise is utilitarian, non-voluntary or under cultural incentives, which is not conducive to enhancing the quality of government members' tacit knowledge. Neglecting the importance of tacit knowledge (33.33 %) and that the tacit knowledge can't be accurately expressed (29.82 %) are the major obstacle to the tacit knowledge sharing. The military enterprise staffs are most willing to seek help from the experienced people (54.39 %), which indicates that the important role of the experience in the tacit knowledge sharing. The survey shows that government departments have the solutions, treatment methods, success experience or failures for specific problems, but don't form a unified specification, and tacit knowledge sharing effect and the speed is poor. Meanwhile, the main bodies of tacit knowledge sharing usually are leaders. The grass-root staffs rarely have the opportunity to put forward their views in the social network. 59.65 % of people said that they took the annual business training less than five times. Therefore, the accumulation of tacit knowledge is difficult to achieve a leap during a period of time.

95.5.2 The Calculation Results Analysis Based on the Structural Holes

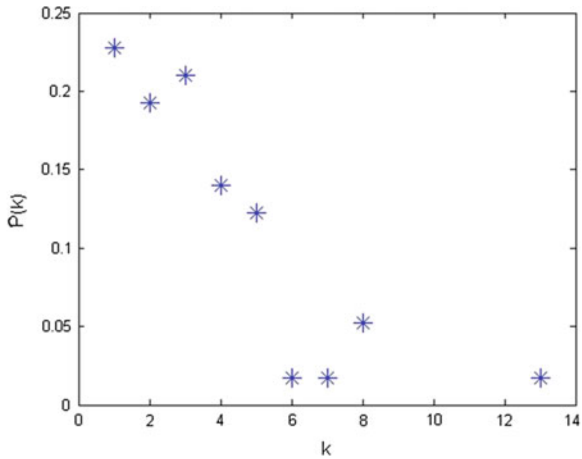
Figure 95.2 shows that there are four levels of the military enterprise's tacit knowledge sharing in social networks. This result is consistent with the status quo of the existing military enterprise bureaucracy. Intermediate potential of the human community map is 0.380, indicating that the majority of the staffs need other members as a bridging point for tacit knowledge and lack of face-to-face to pass tacit knowledge, which explains the inefficiency of government tacit knowledge sharing. From the social relations in theory, the role of an individual in tacit knowledge sharing can be divided into core members, "bridge" members and general members (Cross et al. 2005).

With more "structural holes", which can contact each other, thereby it can reduce redundant information and promote the sharing of tacit knowledge between the military enterprise staffs. The military enterprise staffs can have the opportunity to get more innovation, and then improve the innovative capability of the enterprise. Number 45, 8, 14, 6, 31 are the "bridge" members, they have the largest number of structural holes, occupy part of connection location of the structure holes, so they have formed the Simmel Seoul jointly and severally (Franeis and Sandberg 2000). The structure holes which across the dense zone, occupies structural hole in knowledge sharing or the recipient, they have the opportunity to come into contact with the two heterogeneous sources of information, with access to information and comparative controlling advantage, so it can expand its own knowledge stock, improve knowledge sharing or absorptive capacity, and also can promote knowledge transfer, therefore external social networks and boundary people can bring the change and innovation for the organization.

The network of efficient scale is positively related to tacit knowledge sharing effect, the more abundant members of interpersonal, the more benefit from indirect contact. Shown in Table 95.1, the network of number 1, 57, 50, 56, 7 are large in scale, and have more structural holes, they are core members. Because of the strategic position and others have high dependence on them, these members have more formal authority and more informal power, so they have influence on controlling the flow of information and determine the effect of the military enterprise staffs' tacit knowledge sharing.

There is a negative correlation between structural constraint coefficient and centrality degree of the members and sharing effect, the member who has the

Fig. 95.2 Tree-like chart of structural leveling measurement of the community graph of government tacit knowledge sharing (Partly)



higher structural constraint coefficient and centrality degree benefit less from the knowledge-sharing. The core members and "bridge" members have high betweenness centrality, due to competition, individual differences, policy-oriented and trust, the core members and the "bridge" members were reluctant to share the advantages of resources, and excessive exchanges will waste their energy, all of these lead to their reducing of sharing.

95.6 Conclusion

After analyzing and discussing, the present paper suggests that:

1. There should be a certain size of structural holes in the organization's social network to complete the network connectivity, this can not only reduce the cost of tacit knowledge sharing, but also improve network efficiency and value so as to promote the sharing of tacit knowledge. On the one hand, we can introduce other people from external organization to reduce the centrality of the knowledge of individual; on the other hand, culture tacit knowledge source from the inside can speed the flow of knowledge. Create more shared source within the military enterprise, in order to achieve the target that the military enterprise staffs' tacit knowledge sharing to maximize the effect (Hite and Hesterly 2001).
2. Improve the knowledge-based enterprise, put tacit knowledge sharing into corporate cultural construction (Attiya et al. 2001). Establish a strong culture of sharing, form the same values and code of conduct step by step, speed the exchange of knowledge among the members of the government to shorten the knowledge distance, making tacit knowledge needs to take the initiative to find a source of knowledge, insight and identify their own needs hidden knowledge carriers. In this culture inspired, members of the government have a strong tacit knowledge sharing and absorption willing.
3. the military enterprise should train staff within the organization or introduce the one who has the similar functions of social networks from outside to replace the losing talents, so as to achieve the purpose of repairing tacit knowledge sharing in social networks.

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Chapter 96
Research on Countermeasures of Henan Province Agricultural Products Quality Standard System in the Past Five Years

Ying Shi

Abstract Henan province is a big province in agricultural and food processing. Agricultural products in the national economy play an important role. The impact of quality and safety of agricultural products have a wide range. This paper describes the connotation and function of agricultural products quality standardization, problems in analysis of agricultural products in Henan province in the past five years, on the basis put forward necessity of application of quality control chart detection of agricultural products quality. Zhengzhou Maozhuang agricultural products wholesale market in the last five years based on the detection of pesticide residues in cucumber data, the use of quality control chart method research on pesticide residues, to point out that the application of quality control chart in quality detection of agricultural products promotion possibilities.

Keywords Agricultural products · Quality control chart · Quality standardization

96.1 Introduction

Henan province is a traditional agricultural big province, and it is the important high-quality agricultural products base in the whole country. Sown area and yield of major crops have an important position in the country, wheat, sesame, hemp and jute, garlic, beef, lamb, pig production ranks first. Henan Province, the quality and safety of agricultural products and agricultural market information work in recent years has made some achievements, but there are still some problems to be solved

Y. Shi (✉)
School of Management Science and Engineering, Zhengzhou Institute of Aeronautical Industry Management, Zhengzhou, China
e-mail: shiying@zzia.edu.cn

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(Zhang et al. 2002, 2006). First, the agricultural product quality safety supervision is weak, the detection system is not perfect. Brand name and quantity of agricultural products less and less competitive market. Grain, cotton, oil, vegetables, livestock and other agricultural output of Henan Province tops in the forefront of the country accounted for 1.9 % of the national total, but the number of Henan Province, pollution-free agricultural products, green food, organic food, "Mishina" certification, the gap not small. Third, the market system is not able to meet the needs of the modern marketing, the primary agricultural information system extension is still slow. A long time, agricultural focus only on the quantity of growth, while ignoring the improvement of the quality of agricultural products.

96.2 Current Situation of Agricultural Products Quality Standardization in Henan Province

Five years from 2006 to 2010, standardization construction of Henan province agriculture product has made rapid progress. Especially 2008, related sector according to Henan province vegetable industry of features and development requirements, established vegetable standard system, increased monitoring test efforts, publishing has Kaifeng watermelon, and Zhongmou white garlic, and Xinzheng jujube, and Lingbao apple, 18 a vegetable local standard, formed has 8 a security basket model area, and 35 a model base, and 108 a no pollution-production base, products standardization coverage over 50 %, better to since to has protection agricultural environment of role, Promotes the setting up of healthy cities and sustainable development of vegetable industry.

By the end of 2009, certification of non-pollution agricultural products in Henan province after authorities totaled 1452, product production 15.51 million tons; 330 of green food products production 860,000 tons; 46 of organic agricultural products, production of 23,000 tons of products; cumulative register of geographical indications of agricultural products, 10 products output 3.38 million tons.

By the end of 2010, Henan province has developed more than 700 more items veterinary drugs, and feed, and feed additives, local standard and related animal immunization, and quarantine of local point. At the same time, by Luohe Shuanghui group led of pig farms, and Zhengzhou Huahuaniu company led of cow culture community, and Huangchuan Huaying group led of pension duck field, and Qixian Dayong and Yongda company led of broiler field and pig farms, standardization production has basic been achieved.

96.3 Henan Province for the Past Five Years in the Construction of Agricultural Product Quality Standard System Problem

96.3.1 Low Quality of Fruit and Vegetable

After entering the WTO, fruits and vegetables have a certain competitiveness of Henan province, but lower-quality is also an undisputed fact.

Firstly, it is due to the lack of standardization management in crop production, contribute to a lower quality fruits and vegetables. Taking Biyang County Mushroom production as an example, a few years ago, the County with good natural conditions for large-scale cultivation of pollution-free mushrooms are exported to overseas, became the County's main source of revenue. However, due to the lack of standardized management, in 2007 mushroom production from natural plant development to the greenhouse cultivation, using coal instead of climate natural feature to adjust the greenhouse temperature difference, resulting in lentinus edodes by sulfur dioxide content exceed the standard, and ultimately affect the brand image.

Secondly, it is the implementation of the standards is not strictly, resulting in pesticide residues in fruits and vegetables, excessive heavy metal content. Recently, the science and technology daily front-page headlines reported exports of apples to Europe dropped in a county in Henan province, the County originally exported 300 t of apples from abroad, due to the lower-quality, failed to pass the examination, only sold 20 tones, caused a great deal of loss.

96.3.2 Unsafe Factors of Animal Products

Firstly, current plant and feeding are lack of scientific methodology and management, coupled with the effects of environment (mainly effects of wastes), resulting in excessive content of harmful substances in the agricultural products, livestock products.

Secondly, inspection equipment level in Henan province less developed, many harmful substances cannot be detected. For example, China's exports to Korea, and Japan of vegetable pesticide residue, nitrates and other harmful substances, testing its content more than 200 indicators, while current tested capacity of Henan province has reached only about 50 % of foreign standards requirements.

Monitoring and inspection station in Henan province to funding shortfalls, personnel vacancy currently can only be detected in agricultural products of organic phosphorus composition and urethane components, other players such as content of harmful substances such as heavy metals, nitrates, harmful microorganisms cannot be detected. For example, Japan test items on imported wheat amounted to 114, and only test of quality inspection institutes in Henan province from 20 to 30, in line with the international market there is a considerable gap, directly affecting the province's earnings from exports. In 2011, Due to lack of supervision of the quality inspection departments in Henan shuanghui, the pork "lean" incident has seriously affected the quality of agricultural products in Henan province.

96.3.3 Standard Classification of Rough, the Lack of Effective Monitoring Tools

In recent years, developed a number of agricultural products quality in Henan province industry standards, local standards, but the standards are lower than the international standard of quality safety of agricultural products. Quality grades, packaging, transportation, storage of agricultural products comparative lack of technical standards, classification rough indicators of standards of safety and quality of agricultural products, agriculture, veterinary drug residues in fewer projects, limited number of targeted projects and agricultural food additives residues is poor. Standard content is lack of operability. In the process of production, due to the standardization process of agricultural products requires not only the high production environment, but also strict for every aspects of the production process.

However in currently households of dispersed production, on high HIV high residues agricultural, and veterinary drugs of using and agricultural products in the of agricultural, and veterinary drugs residues and the other harmful substances of content, difficult to do more effective of monitoring, on agricultural products of the quality indicators also difficult to comprehensive, and fast to detection, dealer and consumers often cannot in first time within through appearance distinguished which is quality no pollution-agricultural products, which is non-no pollution-agricultural products, this makes farmers of interests cannot are guarantee, also effects has producer of enthusiasm.

From this five-year agricultural quality standards issues in Henan province (Liu 2008; Fan 2005). It is obviously to see that lack of scientific quality control, monitoring of agricultural quality standards issues outstanding problems, how to make agricultural products from production to processing to marketing chain, are in control of the quality safety of agricultural products becomes the current problems on the most.

96.4 Countermeasures of Agricultural Product Quality Standard System Construction

Henan province's largest agricultural products wholesale market-Zhengzhou Maozhuang agricultural products wholesale market as the research object, although the quality inspection staff each months can from Maozhuang vegetable market detection of pesticide residues in vegetables, but quality inspection personnel is very difficult to obtain a rate range of vegetable pesticide residue from these pure data, and cannot be detected on market situation. Determining the vegetable pesticide residues can achieve risk control point monitoring. Tables 96.1 and 96.2 are the date of cucumber organic phosphorus retention from Zhengzhou Maozhuang agricultural products wholesale market between 2006 and 2010.

According to the market survey from Zhengzhou Maozhuang cucumber vegetable wholesale market of agricultural products, the maximum standard of organic phosphorus content is 0.6745 mg/kg. Quality inspection personnel through the detection has been nearly five years of Maozhuang vegetable wholesale market of organic phosphorus residues in cucumber data, judgment concluded that June 08 cucumber is not eligible. But it is difficult to get from the data control standard of organic phosphorus residue in cucumber, detection of vegetable organic phosphorus residue in cucumber is in a control, an early warning in the organic phosphorus residue in cucumber. Therefore, only these data not only wasted a lot of time of quality inspection personnel, but also from a statistical point of view, these data are of little practical significance.

Application of quality control chart to analyze these data, it can conclude that these statistical data are very significance. Common quality control chart is a mean control chart ($\bar{X} - R$ chart), $X - R_s$ control chart, unqualified frequency control chart (P chart) (Zhang and Li 2000; Wang 2002). Based on the data characteristics, selection of $X - R_s$ control chart.

The average content of organic phosphorus:

$$\bar{X} = \frac{\sum X_n}{n} \tag{96.1}$$

$$\text{Moving range mean}: \bar{R}_s = \frac{\sum R_s}{n-1} \tag{96.2}$$

Table 96.1 2006–2008 Cucumber organic phosphorus content

2006	OPC (mg/kg)	2007	OPC (mg/kg)	2008	OPC (mg/kg)
1	0.6700	1	0.6701	1	0.6693
2	0.6705	2	0.6703	2	0.6698
3	0.6699	3	0.6693	3	0.6697
4	0.6709	4	0.6696	4	0.6690
5	0.6707	5	0.6699	5	0.6706
6	0.6718	6	0.6743	6	0.6748
7	0.6724	7	0.6700	7	0.6718
8	0.6702	8	0.6712	8	0.6702
9	0.6692	9	0.6707	9	0.6703
10	0.6711	10	0.6699	10	0.6710
11	0.6702	11	0.6703	11	0.6702
12	0.6693	12	0.6706	12	0.6715

OPC denotes organic phosphorus content

Table 96.2 2009, 2010 Cucumber organic phosphorus content

2009	OPC (mg/kg)	2010	OPC (mg/kg)
1	0.6691	1	0.6700
2	0.6701	2	0.6697
3	0.6703	3	0.6702
4	0.6698	4	0.6699
5	0.6706	5	0.6705
6	0.6741	6	0.6720
7	0.6707	7	0.6709
8	0.6716	8	0.6724
9	0.6710	9	0.6717
10	0.6706	10	0.6709
11	0.6707	11	0.6706
12	0.6699	12	0.6704

OPC denotes Organic Phosphorus Content

X Control chart control limits:

$$\text{Center line} : CL = \bar{X} \tag{96.3}$$

$$\text{Upper control limit} : UCL = \bar{X} + \frac{3\sqrt{\pi}}{2}\bar{R}_s \tag{96.4}$$

$$\text{Lower control limit} : LCL = \bar{X} - \frac{3\sqrt{\pi}}{2}\bar{R}_s \tag{96.5}$$

R_s control chart control limits:

$$\text{Center line} : CL = \bar{R}_s \tag{96.6}$$

$$\text{Upper control limit} : UCL = D_4\bar{R}_s \tag{96.7}$$

Step 1: getting data

Collate data from the Tables 96.1 and 96.2, X, R_s could be got, as shown in Table 96.3.

Step 2: Calculation of mean

$$\bar{X} = \frac{1}{12}\sum_{i=1}^{12} X_i = \frac{8.047}{12} = 0.6706 \tag{96.8}$$

Table 96.3 X, R_s data

Number	X	R_s
1	0.6697	–
2	0.6701	0.0004
3	0.6699	0.0002
4	0.6698	0.0001
5	0.6705	0.0007
6	0.673	0.0036
7	0.6712	0.0025
8	0.6711	0.0001
9	0.6706	0.0009
10	0.6707	0.0001
11	0.6704	0.0003
12	0.6703	0.0001

Step 3: Calculation of moving range

$$R_s = |0.6701 - 0.6697| = 0.0004 \tag{96.9}$$

Step 4: Calculation of average moving range

$$\overline{R_s} = \frac{1}{11}\sum_{i=1}^{11} R_{si} = 0.00062 \tag{96.10}$$

Step 5: Calculation of R_s control limits

$$UCL = 3.27\bar{R}_s = 3.267 \times 0.00062 = 0.002 \tag{96.11}$$

$$CL = \bar{R}_s = 0.00062 \tag{96.12}$$

$$LCL = 0 \tag{96.13}$$

As shown in Fig. 96.1, 11 R_s plot in this figure.

From the Fig. 96.1, a sample of 6 corresponding to the moving range beyond the upper control limit, tips and in June two adjacent months cucumber organic phosphorus residues difference is apparent, the dispersion is larger, and the difference has obvious statistical significance. Combined with the data analysis, a possible is the annual June cucumber into the mature period, the serious diseases and insect pests, pesticide application amount. On the other hand is high temperature and drought in summer, is not conducive to the loss of most of pesticides, drugs residue in vegetables in greenhouse vegetables, and almost all have been close, the market sells is the vast majority of pesticide residues in food, relatively large. Another aspect is some growers in cucumber not according to safety application of pesticides cucumber picking stages, for economic benefit in cucumber listing.

Step 6: Calculation of X control limits

$$UCL = X + 2.66R_s = 0.6706 + 2.66 \times 0.00062 = 0.6723 \tag{96.14}$$

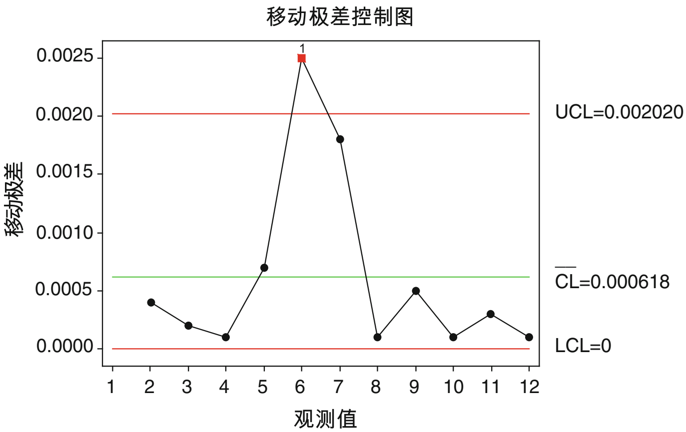

Fig. 96.1 Cucumber organic phosphorus residue R_s control chart (analysis of control chart)

$$CL = X = 0.6708 \quad (96.15)$$

$$LCL = X - 2.66R_s = 0.6706 - 2.66 \times 0.00062 = 0.6690 \quad (96.16)$$

Using Fig. 96.2 to test and manage of cucumber organic phosphorus content from Maozhuang vegetable market. If you find a cucumber organic phosphorus concentrations exceed the control limit, should be timely to find out the reason, and take corresponding measures to solve the problem, to avoid later problems arise. So again and again modify the control of quality control chart limits control standard of organic phosphorus content in more accurate, problems of excessive organic phosphorus content in cucumber will be less and less, thus ensuring the organic phosphorus content in cucumber under the control.

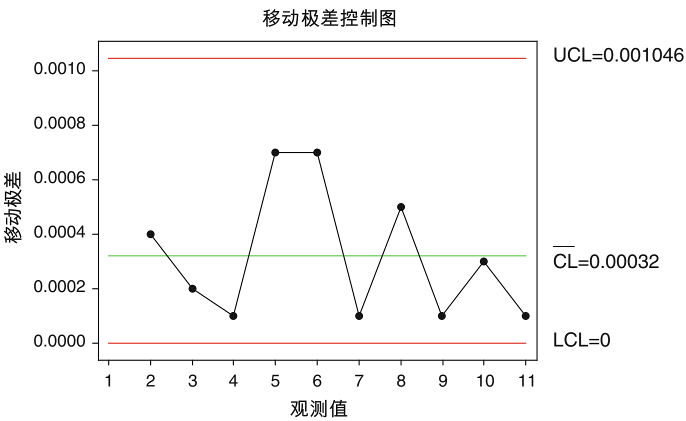

Fig. 96.2 Cucumber organic phosphorus residue $X - R_s$ control chart (management of control chart)

96.5 Conclusion

Quality standard is to measure the quality of a fundamental basis. Advantages and disadvantages depending on the standard of quality, improving the standardization of quality and the implementation of a consistent purpose and guiding principles. One of the quality requirements is inherent in the standards, should meet, and could use a certain quality requirements for testing methods are the core standards of agricultural products. Through the standardization of quality management and control, agricultural product quality can be improved. Quality management is to ensure the quality of products or jobs reaches or exceeds the standard requirements of a range of activities.

Agricultural standardization activities throughout the quality has always been agricultural quality control essentially dynamic perfection of agricultural standards to achieve the objective of improving the quality of agricultural products, quality standards for quality of the process of agricultural industrialization requirements using standard forms of fixed, integrating quality management into the standardized and scientific, international track. Use of control charts can be well developed criteria to monitor the quality of agricultural products within the scope of control. Producers can use control charts for dynamic monitoring of production processes of agricultural products, guarantees the production process under control. Problems can be identified and resolved in a timely manner, ensuring the quality of agricultural products increasingly higher levels. Quality control personnel can be quickly detected by control charts, guarantee the quality and safety of agricultural products in the market, while efficient allocation and monitoring force, to a large extent, solved the problem of inadequate testing personnel in Henan province. Control chart in quality agricultural products there is a great deal of research and utilization value of security control.

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Chapter 97
Research on the Effect of Leader Evaluation on the Employee Knowledge Sharing: The Moderating Effect of Process Oriented

Li-ling Cai and Gong-min Bao

Abstract Based on the extant literature, organization contextual factors are important for organization to motivate employee's effort to take part in the knowledge sharing activities. This paper advances extant literature by investigating one of the key contextual factors which pays attention on leader evaluation, explores the effect of leader evaluation on employee knowledge sharing. The results show that leader positive evaluation has a positive effect on employee knowledge sharing, but leader negative evaluation has a negative effect on that, furthermore, the effect of leader negative evaluation on employee knowledge sharing will weaker when leader evaluation with process oriented is strong rather than weak.

Keywords Knowledge sharing · Leader negative evaluation · Leader positive evaluation · Process oriented

97.1 Introduction

Knowledge sharing is considered to be the most important part in the domain of knowledge management researches. Successful knowledge sharing can directly promote knowledge creation, and help organization keep the sustainable

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L. Cai (✉) · G. Bao
Department of Enterprise Management, Zhejiang University, Hangzhou, China
e-mail: eleen1981@163.com

L. Cai
Fashion College, Zhejiang Sci-tech University, 310018 Hangzhou, China

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competitive advantages. So it's valuable for company to find out the key driving factors or obstacles for knowledge sharing. Among above factors, some researchers are paying attention on leader support and leader motivating way. Such as positive evaluation, which is considered to be helpful for organization to build an active atmosphere, and promote knowledge sharing activities between employees. However, other researchers find that positive motivation in China is not correlative to employee knowledge sharing, but punishment has a positive effect on that (Jiacheng et al. 2010). Evaluation is an important way for leader to motivate and control employees' behavior and performance, it will influence employees' attitude, intent and real behavior. On what context that leader evaluation can be helper for organization to motivate employee knowledge sharing? There is little research pay attention on the relationship between leader evaluation and employee knowledge sharing. In this study, we will pay our attention on leader evaluation type and its effect on employee knowledge sharing, as well as the moderating role of process oriented, which is a key moderating variable for this research.

97.2 Relevant Literature

97.2.1 Leader Evaluation

Early evaluation literature uses single dimension to research evaluation characteristics, as "expected external evaluation" (Shalley and Oldham 1985). As researchers go deep into the research on evaluation dimensions, multidimensional variables become popular gradually. In this study, we see evaluation as a multidimensional variable, which includes different types and focuses. On type angle of view, leader evaluation has two types, which are positive evaluation and negative evaluation. Positive evaluation is that leader is inclined to treat his or her employees with a positive way, such as praising and encouraging them at usual. The other way round, negative evaluation is that leader is inclined to treat his or her employees with a negative way, so criticism and denial are usual to be used for leader to evaluate employee's behavior or performance.

In the next place, when people are evaluating the other one, they will find out or base on some clues or focus on some orientation, that is process oriented or outcome oriented evaluation, which is some kind typical classified mode. Moreover, Cognitive neurology has proved that people are steady stayed on one of cognitive mode on the given time, outcome or process focus (Blajenkova et al. 2006; Kozhevnikov et al. (2005). Basing on the above researching discoveries, we deduce that leader is also inclined to one steady cognitive way, when he or she evaluates employee's work. That is, if leader is oriented to process evaluation, he or she will pay more attention on employee's behavior and contribution in work process, if leader is oriented to outcome evaluation, the project result or indexes are more important for him or her to control employee's work (Jaeger and Baliga 1985; Ouchi 1979).

97.2.2 Knowledge Sharing and Its Contextual Factors

Knowledge sharing is something that knowledge is transferred and transformed among individuals. Through provider and receiver communicating their knowledge each other, knowledge can pervade from individual level to team level, and organization level, and then individual knowledge will become organization knowledge gradually. By knowledge integrating and applying, knowledge can be used to develop new products, and knowledge innovation will make organization keep the sustainable competitive advantages. Knowledge sharing is the unique important resource for organization to build competitive advantages (Nonaka and Takeuchi 1995; Prahalad and Hamel 1990). Successful knowledge sharing needs to manage and control the organization factors which will influence knowledge sharing effect.

Among so many contextual factors, organization contextual factors are more important for organization to motivate employee's effort to participate in the knowledge sharing activities. Based on the extant literature Jewels and Ford (2006) find that the contextual factors can be divided into driving factors and impeditive ones, individual knowledge sharing intention is influenced by individual motive, team arrangement and employment practice. From social capital angle of view, Wah et al. (2007) find that reward motivation, open mind, hiding knowledge cost and sharing knowledge cost are more important than organization care for knowledge sharing. Gagne (2009) puts forward a human resource management practice model based on plan behavior theory and self-determination theory, but he does not prove it by demonstrations. Furthermore, Nicolai et al. (2009) find that work design (freedom work, consistent task and feedback) has an significant effect on employee knowledge sharing through the questionnaire way. For the moment, most researches about organization contextual factors focus on multiple integrating effect, and the single factor's influence is being noticed, however, there is little studies which have assess the single factor angel, such as "leader evaluation". To fill these research gaps, we will examine how leader evaluation influences employee knowledge sharing.

97.2.3 Research Hypotheses

Employee knowledge sharing is an interactive communication process, which includes formal communication and informal communication between individuals. However, knowledge sharing system can not to be compelled (Hendriks), contrary, it is a voluntary and conscious behavior, motivating and driving can be helper to promote it (Gibbert & Krause). Bryant (2003) finds that team members would like to share knowledge when leader awards and punishes them equally, if unequal, their intention on knowledge sharing will decline, but it not significant connect. When leader pay more attention on employee work and interpersonal, it can improve employee knowledge sharing. Leader positive evaluation is a positive inducing method to employee. When leader sees employee behavior or performance with a positive way, employee's activities on work will be stimulated, and then he or she will share knowledge with others with pleasure better and better.

Hypothesis 1a: leader positive evaluation has a positive effect on employee knowledge sharing.

Hypothesis 1b: leader negative evaluation has a negative effect on employee knowledge sharing.

When evaluating employee at work, some leaders will prefer to judge them depending on whether they are complying the operation rule and criterion, and then they can control or correct employee's behavior. Given more detail, evaluation with process oriented is that leader will restrict employee's work process and procedure, and pay more attention on employee's behavior and process but outcome or object. On the context of process oriented, employees will work harder when they are praised by leader, for they think their endeavors are acknowledged by organization. On the other hand, employees will seen criticism as the unequal treatment, and then bring depression and discourager, so they will do less positive behavior.

Hypothesis 2a: The effect of leader positive evaluation on employee knowledge sharing will stronger when leader evaluation with process oriented is strong rather than weak.

Hypothesis 2b: The effect of leader negative evaluation on employee knowledge sharing will weaker when leader evaluation with process oriented is strong rather than weak.

97.3 Methodology

97.3.1 Sampling and Data Collection

To test the hypotheses, we examined 30 firms in high-tech sectors located in Chinese cities at Zhejiang province. For gathering the required data, we used semi-structured interviews and questionnaires. All responders were interviewed and completed questionnaires, as a result we gained 140 valid questionnaires, which is a response rate of 70 %.

97.3.2 Measures

We adapt the measures in the survey from established studies, the measure all perceptual scales using a five-point Likert scale (for leader evaluation type, 1 = less than once a month, 5 = several times per day; for process oriented and knowledge sharing, 1 = strongly disagree, 5 = strongly agree).

Leader evaluation type. We adapt items from Ashford (1986) and David and Martin (1977), each including 4 items. Before presenting these items we briefed our responders to take a moment and think about occasions in which they got evaluation from their leader during their everyday work. We assessed frequency of positive and negative evaluation from the supervisor. Sample items are "During the last six months, how often did you receive positive evaluation from your supervisor", "During the last six months, how often did you receive negative evaluation from your supervisor".

Process oriented. We adapt items from Snell (1992) and Govindarajan and Fisher (1990) including 4 items. Such as, "Leader pay more attention on when employee should complete their subtasks", "When evaluating employee's performance, leader pay more attention on their behavior and process".

Knowledge sharing. We follow (Hooff and Ridder 2004), which include 7 items (i.e., I will share my knowledge with my colleague, I will share my technology with my colleague).

Controls. We include gender, age, education and working year as control variables.

97.4 Data Analysis

97.4.1 Validity and Reliability

In our research, all Alpha values of the variables are higher than 0.8, the load values are higher than 0.6. All of items are fitted to run a factor analysis (KMO = 0.770, Bartlett Sig. <0.001). According to Table 97.1, these measures demonstrate adequate validity and reliability.

97.4.2 Descriptive Statistics and the Variable Correlations

Table 97.2 reports the descriptive statistics and the variable correlations. Correlation values of variables are lower than 0.70. According to the correlation analysis, leader positive evaluation, negative evaluation and process oriented are correlated with employee knowledge sharing.

97.4.3 Regression Analysis and Moderating Effect

We used regression analysis to test the hypothesis. We mean-center all independent variables that constitute interaction terms and then create interaction terms by multiplying the relevant mean-centered variables (Aiken and West).

Table 97.1 Analysis on the reliability and validity of variables

Variables	Index	Load	Alpha
Positive evaluation	1	0.919	0.891
	2	0.889	
	3	0.885	
	4	0.883	
Negative evaluation	1	0.816	0.813
	2	0.721	
	3	0.742	
	4	0.672	
Process oriented	1	0.614	0.804
	2	0.698	
	3	0.693	
	4	0.742	
Knowledge sharing	1	0.772	0.870
	2	0.782	
	3	0.883	
	4	0.745	
	5	0.794	
	6	0.863	
	7	0.690	

As we show in Table 97.3 (model 1), leader positive evaluation has a positive effect on employee knowledge sharing ($\beta = 0.224$, $p < 0.01$), leader negative evaluation has a negative effect on employee knowledge sharing ($\beta = -0.162$, $p < 0.05$). These results fully support both Hypothesis 1a and 1b. The process oriented doesn't play the moderating role on the effect of leader positive evaluation on employee knowledge sharing (model 3), but the effect of leader negative evaluation on employee knowledge sharing will weaker when leader evaluation with process oriented is strong rather than weak (β = -0.377, $p < 0.001$). These results support Hypothesis 2b but reject Hypothesis 2a.

97.5 Discussion

Prior conceptual and empirical work shows that knowledge sharing will be influenced by organization contextual factors. Our study advances extant literature by investigating one of the key contextual factors, which pays attention on leader evaluation. We choose leader evaluation type as the key predicting variables, and use leader evaluation oriented, exactly "process oriented", as the moderating variable. Overall, our results show that different evaluation type will influence employee behavior in different way, positive evaluation has a positive effect on employee knowledge sharing, but positive evaluation has a negative effect on that. Our study also find, when leader evaluation with process oriented is strong rather than weak, the effect of leader negative evaluation on employee knowledge

Table 97.2 Descriptive statistics

Variables	M	SD	1	2	3	4	5	6	7
Gender	1.185	0.390	–						
Age	3.260	1.272	−0.140	–					
Education	2.990	1.014	0.185*	−0.383**	–				
Working year	3.590	1.488	−0.166*	0.654**	−0.440**	–			
Positive evaluation (PE)	3.222	0.986	−0.066	0.100	0.039	0.087	–		
Negative evaluation (NE)	1.598	0.678	−0.093	−0.079	0.091	−0.020	−0.067	–	
Process oriented (PO)	2.120	0.655	0.188*	−0.088	−0.022	−0.094	0.002	−0.663**	
Knowledge sharing	3.897	0.709	0.095	0.091	−0.068	0.151	0.252**	−0.182*	0.403**

* $p < 0.05$, ** $p < 0.01$

Table 97.3 Regression Analysis

Variables	M1	M2	M3
Control variables			
Gender	0.124	0.092	0.085
Age	−0.204	−0.153	−0.222
Education	−0.027	−0.020	0.005
Working year	0.309	0.294	0.348*
Direct effect			
Positive evaluation (PE)	0.224**	0.250**	0.291***
Negative evaluation(NE)	−0.162*	0.027	−0.283*
Process oriented (PO)		0.284**	0.182
Interactions			
PE × PO			−0.021
NE × PO			−0.377***
R^2	0.133	0.175	0.250
F	3.389**	4.007**	4.820***

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

sharing will weaker. So leader should be cautious to treat employee as a negative way when he or she pay more attention on employee's behavior or process. From motivation angle of view, evaluation is a kind of mental stimulation, and it's different to money stimulation. Prior empirical researches find that positive motivation in China is not correlative to employee knowledge sharing, maybe it pay attention on money or matter stimulation but not mental motivation, so employee' intention on knowledge sharing is not to be excited.

When studying the moderating effect of evaluation oriented, we just probe into process oriented only for briefing our research model. We hope that further research continues to explore the other evaluation oriented, such as outcome oriented. Otherwise, prior researches have find that contextual factors can't be restricted in organization, national culture, is key for people to understand why employee would like or not to sharing their knowledge (Michailova and Hutchings 2006), especially the tacit knowledge. There may be some mediating variables between leader evaluation and employee knowledge sharing, it's interesting to find out them in the future.

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Chapter 98
Analysis on Pricing of Vegetables in Supermarkets Based on Consumer Surplus

Yuan-yuan Yu and Li-wei Bao

Abstract The transactions between supermarkets or agricultural trade markets and consumers are in the downstream of agricultural supply chain. China has seen a surge in the popularity of many supermarkets running fresh agricultural products such as vegetables. Some consumers buy vegetables in supermarkets instead of in agricultural trade markets. Consumers enjoy better shopping experience for the comfortable environment, credible quality and perfect service. Whereas, we also observe that pricing of vegetables in supermarkets is higher than in agricultural trade markets. Then, the target of this paper is to discuss how to fix the price in supermarkets so as to guarantee consumer volume and not go into the red. In this paper, we use the conception consumer surplus to explain the pricing strategic in supermarkets.

Keywords Consumer surplus · Pricing · Supermarket · Vegetables

98.1 Introduction

In recent years, merchandise categories increase in supermarkets. As we all know, the transactions between supermarkets or agricultural trade markets and consumers are in the downstream of agricultural supply chain so that when purchasing agricultural products, taking vegetables as an example, consumers can buy both in

Y. Yu (✉)
School of Management, Zhejiang University, Hangzhou, People's Republic of China
e-mail: yuanyuanyu3861@126.com

L. Bao
School of Business, Zhejiang University City College, Hangzhou, People's Republic of China
e-mail: baolw@zucc.edu.cn

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supermarkets and in farmers' markets. The latter is the major competitor of the former. Agricultural trade markets are dominated by individual peddlers and vendors, in which business scope is flexible and mobile, market reaction is fast and cost per unit is low (Zhang 2006). However, supermarkets are more competitive in the aspect of shopping environment, food safety, quality of service, reputation and so forth (Mao 2010), so that the price in supermarkets is higher than that in agricultural trade markets for the higher operating cost. This allows for a tradeoff between consumer volume and profit if optimum results are to be obtained. The vegetables in supermarkets are expected to be priced at a reasonable level on the premise of guaranteeing quality (Du 2009).

Many scholars have studied the pricing strategy of vegetables in supermarkets. Some provide a pervasive means to determine the price (Wang and Zhou 2007; Su 2009), some analyze the scope of pricing strategy (Wang 2006; Lu 2010; Lin et al. 2006), and others put the emphasis on implications on consumers in terms of existing pricing strategy (Gong 2010). Lots of researchers hold the view that supermarkets running fresh agricultural products relates to consumers' purchase intentions (Ding 2008; Yuan 2008; Tang 2011). This paper has accomplished quantitative analyses from economic perspective, namely consumer surplus. Examination of such point of view may provide some insights into the possible future development of pricing strategy.

98.2 Conceptions and Hypotheses

In this section, we introduce some conceptions. The first one is customer order volume which means the average amount of goods every customer buy in shopping malls or supermarkets. That is a quite important measurable indicator relating to store operations and therefore we get the calculating formula: customer order volume = the amount of sales/the number of trade orders. The second conception is consumer volume which indicates within a certain time, the number of customers travelling in a section along one direction. Then we can obtain the sales of a particular vegetable equal customer order volume multiplied by consumer volume. In economics, consumer surplus is the gap between the costs a customer would like to pay and the costs he actually pays through the consumption of specific goods or service. Consumer surplus represents the consumer's gains from trade. It is well known that value is intrinsically related to the worth derived by the consumer so that the gap is difference between the total utility a consumer gets and pays.

Our hypothesis is close to reality at an abstract level. Therefore,

Hypothesis 1 Supermarkets' pricing strategy is bound up with many factors such as pricing targets, purchasing channel, level of demand and so on. In this paper, we think supermarkets aim to increase popularity and attract customers in the way of quick sale and small profits.

Hypothesis 2 We take no account of industry competition but competition with free markets of agricultural products.

Hypothesis 3 Supermarkets can provide elegant shopping environment, guarantee of quality and perfect service for consumers and hence, shopping experience in supermarkets is better than in agricultural trade markets so that the selling price in supermarkets is higher.

98.3 Analysis

Supermarkets manage a variety of vegetables, whereas not every category has high margin. The purpose of increasing consumer volume impels supermarkets to price in a reasonable way so that they can be still in the black on the vegetables business. We suppose there are 30 kinds of vegetables, each with corresponding to categories, i, customer order volume, Si (i = 1, 2,…, 30).

If consumer volume is m, then the sales for *i*th are Qi = Si·m so the total sales for the whole vegetables are Q = ΣQi. We shall use Pi for *i*th vegetable's price then we get sales profit for *i*th vegetable in one day, Ei = Pi·Qi-wi·Qi in which wi stands for the cost of *i*th vegetable. The total profit of all vegetables will be defined as

$$\mathrm{E} = \sum \mathrm{Pi} \cdot \mathrm{Qi} - \sum \mathrm{wi} \cdot \mathrm{Qi}.$$

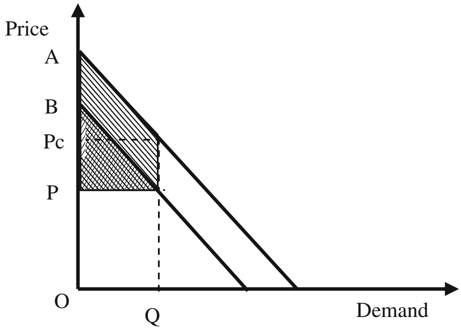
The supermarkets are expected to ensure E > 0.

As we have assumed, supermarkets can provide elegant shopping environment, guarantee of quality and perfect service for consumers and hence, shopping experience in supermarkets is better than in agricultural trade markets. This implies that consumer can gain more consumer surplus. Henceforth supermarkets can raise ΔP based on the agricultural trade markets' price. Unknown, however, is what condition should be satisfied for ΔP.

We shall use U to denote utility, then ΔU = ΔP·Q which reveals that the difference between the amount of consumption in supermarkets and that in farmers' markets represent consumers' extra satisfaction only if they buy products at farmers' markets price. The extra satisfaction including time and energy, convenience, comfort, distance, buying habits and the like cannot be measured by money. Consumers may feel the same personal satisfaction if supermarkets set retail price at Pn + ΔP, provided Pn is the retail price of agricultural trade markets. ΔP is the maximum differential price limiting or it can be interpreted as the maximum money consumers prefer to pay for the improving shopping experience in supermarkets. It reflects value evaluation of shopping experience improvement. A determination of how much ΔP should be is the mainly question in this paper.

In the following section, let us analyze this question with intuitive diagram. A stands for demand curve of supermarkets, and B is that of agricultural trade markets. When price is equal, quantity demanded in supermarkets is greater than in agricultural trade markets as we have assumed that there are elegant shopping

Fig. 98.1 Demand curves of supermarkets and agricultural trade markets



environment and guaranteed quality in supermarkets. Pc is the retail price in supermarkets, namely

$$\mathrm{Pc} = \mathrm{Pn} + \Delta \mathrm{P}$$

with Pn the retail price in agricultural trade markets. The areas shaded in gray are consumer surplus at Pn price selling Q in supermarkets. The crosshatch represents consumer surplus in agricultural trade markets. Diagonal shadows are the extra consumer surplus at Pn price.

Figure 98.1 illustrates the above.

As we have assumed, m is consumer volume, the m consumers buy vegetable i in supermarkets instead of agricultural trade markets for the supermarkets can provide more fulfillments. We can write

$$(\mathrm{Pik} - \mathrm{Pni}) \cdot \mathrm{Sik} \leq \mathrm{Uik}\ (\mathrm{k} = 1,\ 2\ldots 30)$$

to express the extra fulfillments where Pik stands for the price *k*th consumer wish to pay for *i*th vegetable.

ΔUik is the extra utility (satisfaction) the *k*th consumer feels from *i*th vegetable, Pni indicates the retail price of *i*th vegetable in agricultural trade markets and Sik represents the quantity the *k*th consumer buy with $\mathrm{Si1} = \mathrm{Si2} = \ldots \mathrm{Sik}\ldots = \mathrm{Sim} = \mathrm{Si}$.

The utility of the m consumers is calculated as the total utility writing

$$\left(\sum \mathrm{Pik} - \mathrm{m} \cdot \mathrm{Pni}\right) \mathrm{Si} \leq \Delta \mathrm{U}$$

where ΔU denotes the whole utility combined, and then we get

$$\left(\sum \mathrm{Pik} - \mathrm{m} \cdot \mathrm{Pni}\right) \leq \Delta \mathrm{U}/\mathrm{Si}.$$

Let ΣPik/m = Pi, therefore,

$$\mathrm{Pi} - \mathrm{Pni} \leq \Delta \mathrm{U}/(\mathrm{m} \cdot \mathrm{Si}) = \Delta \mathrm{U}/\mathrm{Qi}.$$

The maximum average price of *i*th vegetable in supermarkets is Pni + ΔU/Qi, and the minimum average price of *i*th vegetable in agricultural trade markets is Pi − ΔU/Qi. Specifically, Pi is the mean value the m customers can accept because different customers have different time, energy and preferences.

As analyzed above, if supermarkets want to ensure E > 0, then it satisfies

$$\mathrm{E} = \sum \mathrm{Pi} \cdot \mathrm{Qi} - \sum \mathrm{wi} \cdot \mathrm{Qi} > 0$$

and furthermore, we think that the total quantity of *i*th vegetable is determined by shelf life multiplied by customer order volume.

98.4 Conclusions

This article provides the way to ensure the price of fresh agricultural products in the downstream of agricultural supply chain. However, we can calculate the results when knowing the exact function of demand which is not always well defined. The purpose of this paper is to use the conception consumer surplus to reveal the pricing strategic in supermarkets and it also contributes to explain the reason why price in supermarkets is higher than that in agricultural trade markets. This is kind of improvement and we hope that further research continues to explore and document deeper phenomenon during transaction of agricultural products in supply chain.

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Chapter 99
CAVE Based Visual System Design and Implementation in Marine Engine Room Simulation

Hong Zeng, Jun-dong Zhang, Wen-long Yao and Xiao-jun Zhang

Abstract Marine engine room simulation system can use for crew training, teaching practice, researching performance of ship power system and the auxiliary equipments. This paper introduces the hardware design, software module planning and key technologies of the engine room visual simulation system base on CAVE. A series of optimization methods from model to real-time rendering are proposed for the engine room virtual scene has many complex 3D entities and mapping. The following key technologies of CAVE software are discussed, including multi-channel synchronization mechanism, stereo vision algorithm, the modeling and maneuvering of engine room virtual scene. These techniques and methods have been successfully applied to the developed multichannel visual engine room simulator.

Keywords Virtual reality · CAVE · Marine · Engine room simulator · Multi-channel synchronization · Stereo vision

99.1 Introduction

With development of computer graphics, virtual reality technology has been applied to marine engine room simulator in recent years (Cwilewicz and Tomczak 2008; Zhou et al. 2010; Jun et al. 2007; Zeng et al. 2007). Companies such as Norway Kongsberg, Poland Unitest have developed virtual marine engine room roaming system, and realized equipments operation in virtual scene. But the systems are designed for single PC desktop and lack sense of immersion. The scene observation is passive roaming following a fixed path, not active roaming in

H. Zeng (✉) · J. Zhang · W. Yao · X. Zhang
Marine Engineering College, Dalian Maritime University, Dalian, China
e-mail: kevinzeng2006@126.com

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real time, the equipments operation in scene is fewer. Universities such as China Dalian Maritime University, Wuhan University of Technology, and Jimei University (Zeng et al. 2007) have developed, in recent years, virtual engine room roaming systems, but the visual contents are simple.

As the constant pursuit of immersion in visual simulation technology, various virtual reality environments emerged, such as column screen, the ball screen, dome screen and the cave automatic virtual environment (CAVE) (Hegie et al. 2010; Lee 2010; Yuen et al. 2010). Three-channel column screen is the most popular application, but its immersion sense is inadequate. 360° column screen is suitable for marine navigation simulator because of the maximum horizontal field of view (Yong et al. 2009). But for a smaller vertical field of view, it is not suitable for looking down or looking up occasions. CAVE can achieve the maximum field of view in both vertical direction and horizontal direction. It is the most immersive virtual reality environment.

The paper realizes the stereoscopic active roaming in virtual engine room scene, virtual equipments maneuvering, and engine room process simulation. The designed cave can use for marine simulation training and other research field.

99.2 Design of Cave Marine Engine Room Simulation System

The system is a five-channel virtual reality simulation environment, based on engine room process mathematical model and 3D graphics engine. The following hardware and software subsystems were introduced.

99.2.1 Hardware

Hardware consists of five-wall rear projection, interactive devices, stereo, engine control console and PC cluster. Figure 99.1 shows the structure of a five-channel CAVE. Five PC slaves were responsible for each projection screen. Slaves render stereo image pairs for the projectors. With two projectors each wall, the left eye and right eye images are projected. To lessen the installation space, a front surface-coated mirror is used to reflect the image to the rear projection screen. Polarized lens installed before the projectors so that optical wave vibrates in a specific direction. Observers wear polarized glasses. Each eye only receives light from the corresponding projector

Observers in the CAVE interact with the virtual world by various interactive devices. Infrared camera installed behind the front screen captures observer's gestures. Tracker worn on the body captures observer's six degrees of freedom movement, thus control the first person roaming in virtual scene. Flying joystick

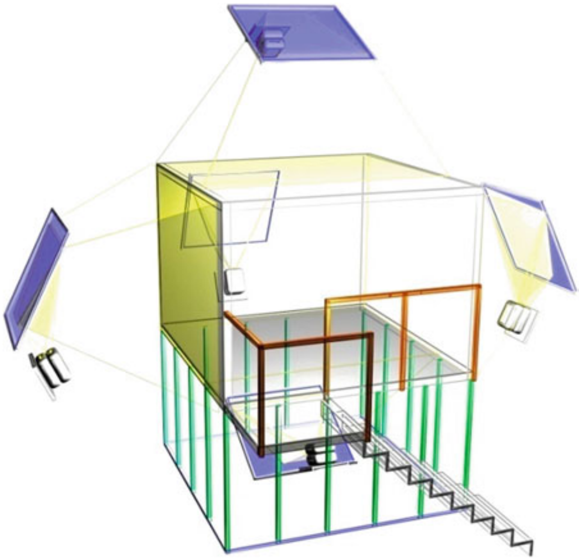

Fig. 99.1 Structure of a five-channel CAVE

held by the observer to control the first person roaming also. The difference between tracker and flying joystick is that tracker offers observer a better interactive experience, but because of CAVE size limits, the observer cannot go too far (Smit and van Liere 2009), here we can use flying joystick to roam father. Mouse picks up the 3D virtual objects, operates the virtual equipments. Engine control console is a typical engine room operating panel units, it can be arrange at CAVE entrance to give the operator real operating experience in the form of hardware in loop simulation. Stereo play engine room background noise and sounds during equipments starting, running, maneuvering.

PC cluster run engine room process mathematical model, 3D graphics engine, mimic simulation software, front buffer process software. Master, slaves and console communicate by Ethernet (Fig. 99.2).

99.2.2 Software

In terms of function, software consists of engine room simulation kernel module, visual simulation module, mimic simulation module, front buffer process module. The module function is as follows:

1. *Engine Room Simulation Kernel Modules*

- Calculation of engine room process mathematical model (Zeng et al. 2010), including propulsion system, power plant, control systems, ship pipe systems, auxiliary equipments.

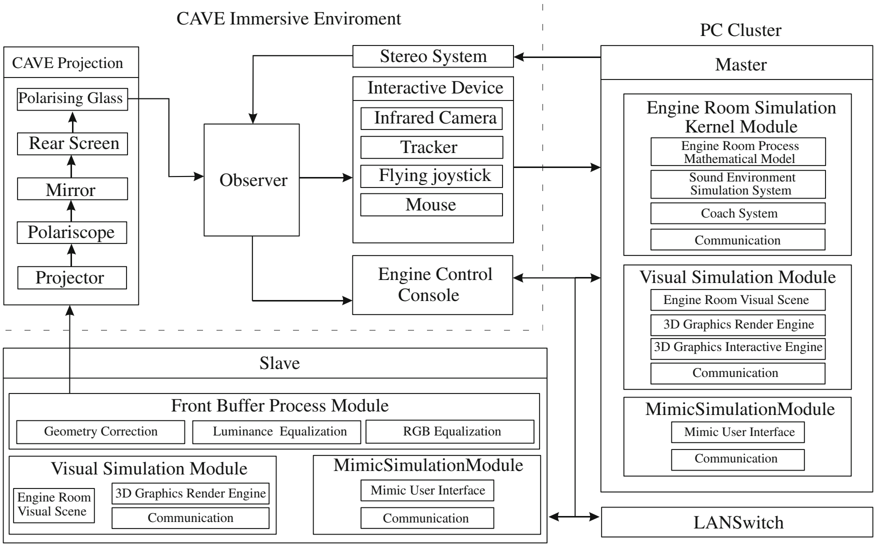

Fig. 99.2 Schematic diagram of cave engine room simulation system

- Sound environment simulation system, to simulate the background noise, sounds during equipments starting and maneuvering, breaker on-off sound, alarm sound, reverberation and volume control.
- Coach system, including malfunction setting, evaluation system, scenario save and load, system settings.
- Communication module, to receive the virtual equipments operation signal and send simulation data.

2. *Visual Simulation Module*

- Engine room 3D visual database, including the engine room structure, main engine, diesel generators, separators, steering gear, fresh water generator, propeller, piping and valves, air compressors, tanks, pumps and other equipments' 3D model and material.
- 3D graphics interactive engine, to control the first person roaming, achieve collision detection, 3D pick-up, 3D entities interaction logic and animation, receive operation on virtual equipments.
- 3D graphics render engine, for dynamic loading visual database, containing CAVE multicamera model, to realize stereo imaging algorithms, to show simulation data in the forms of meter pointer, valve rotation, indicator on–off, to complete real-time rendering of stereo images.
- Communication module, to send the virtual equipments operation signal and receive simulation data, to synchronize multichannel rendering process.

3. *Mimic Simulation Module*

- The mimic user interface shows the principle of engine room process, including main engine, diesel generators, auxiliary equipments, piping. The simulation data refresh real-time on the user interface, the user operates virtual equipments through controls.
- Communication module, to send the equipments operation signal and receive simulation data.

4. *Front Buffer Processing Module*

- Geometric correction, to warp the front buffer image, for eliminating the deformation caused by the projector, mirror mounting angle, screen frame, making the image perfectly matched the screen.
- Luminance and RGB equalization, to adjust gamma value, RGB color components by pixel in the front buffer, make the image observed uniform.

Among the above modules, engine room simulation kernel module is the soul of the simulation system. It is responsible for receiving user operation, calculating mathematical model, feeding back the simulation results to user. Visual simulation module and mimic simulation module present the results in the form of 3D scene and mimic diagram.

Master runs engine room simulation kernel module, visual simulation module, and mimic simulation module. Slaves run visual simulation module, and mimic simulation module, front buffer processing module. Visual simulation module on slaves don't need 3D graphics interactive engine. All interaction and simulation calculation is complete on master. Slaves are only responsible for rendering the image.

99.3 Key Technologies Research of Cave

99.3.1 Multichannel Synchronization Mechanism

CAVE distributes the image rendering task to every channel. Observer eyes position and orientation is same in each channel, but camera orientation is different. To get right scene in CAVE, first the image of each channel should correctly splice into the whole image. Second, camera position, orientation and simulation data of each channel should synchronize in real time. If the engine room scene image is out of sync at a time, even though the projection image correctly splice, the observer will see scene image tearing. Reasonable dividing of projection space can make the projection plane splice seamlessly. Multichannel synchronization is realized by network communication. Figure 99.3 shows the engine room scene spliced image rendered by five slaves.

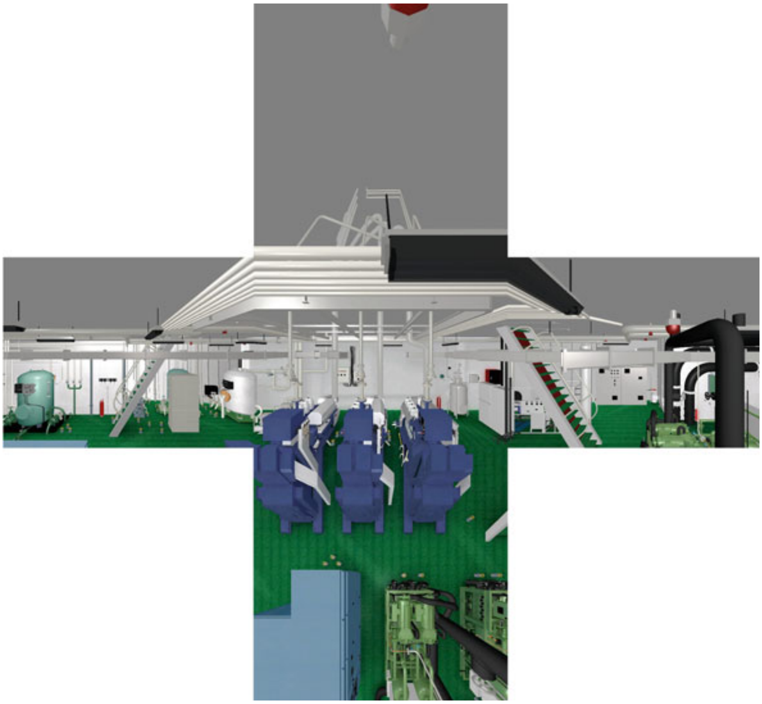

Fig. 99.3 Five channels spliced image of engine room scene

The content of sync communication during rendering process is mainly about channel cameras' position and orientation, which simulate observer's left and right eye, and rendering complete signals. Figure 99.4 demonstrated the synchronization process of rendering. Before frame rendered, master handles the information from tracker and flying joystick, controls camera group's position transformation and rotation transformation, then broadcasts the camera parameters to network through UDP protocol. After received the datagram, slaves extract the camera parameters for its own channel, then render the scene. Slave will send complete signal to master after finishing rendering. It will not render again until receives camera parameters of next frame. As number of bytes is less during communication, the synchronization process will not slow down the frame rate of entire scene.

Besides synchronization rendering, the simulation data presents on multi-channel should synchronize also, otherwise it will degrade user's sense of reality. Data synchronization process is as follows. The data need communicate are compiled into database. Each slave has a copy of database. Simulation results on master are sent to network by another communication thread. After receiving data, slave will update its database. During rendering, the 3D entities property can be looked up from database. To reduce communication load, it need to compare old

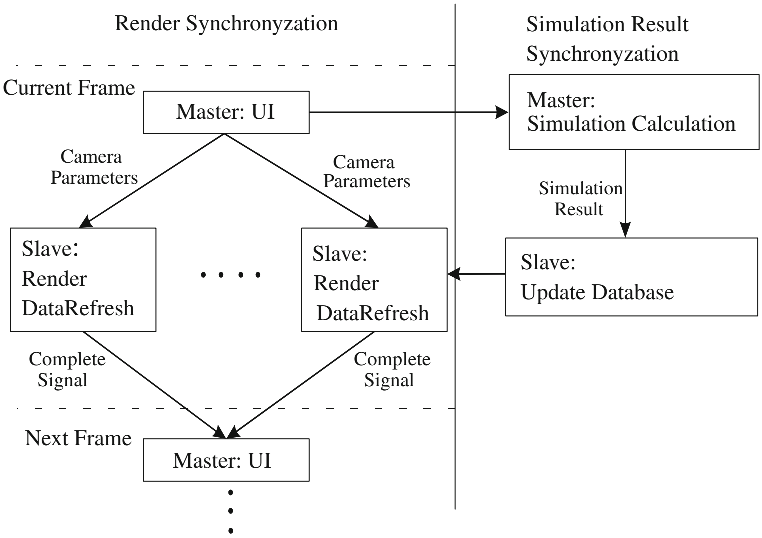

Fig. 99.4 Flowchart of multichannel synchronization process

value and new value before sending. Only the error reach the trigger setting the data can add to send queue.

99.3.2 Stereo Vision Algorithm

Stereoscopic display technology is based on the principle of binocular parallax. By auxiliary device, viewer eyes see different images. Finally combined with sound, environment, and psychological suggestion, stereo image with real physical depth of field formed. Stereo image pair generation algorithms are mainly two: binocular

Fig. 99.5 Schematic diagram of stereo vision algorithm. **a** Binocular convergence. **b** Binocular parallel

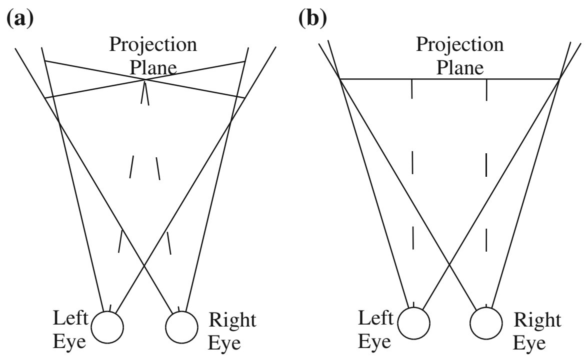

Fig. 99.6 Stereo image pair of engine control room

convergence projection algorithm and binocular parallel projection algorithm (Zijian et al. 2010; Meng et al. 2008) (Fig. 99.5).

Binocular convergence projection algorithm simulates human eyesight convergence effect during observing objects. Therefore, the algorithm is suitable for virtual disassembly under empty background scene. However, the algorithm will make the two projection planes nonparallel. As a result, the parallax of stereo images pair deranged, the observer will feel a regulatory discomfort, even nausea and vertigo.

Binocular parallel projection algorithm avoided the parallax derangement. It can bring a large and comfortable three-dimensional realism. But as the cone of camera is symmetric in most graphics engine, the image generated by this algorithm needs clip before projected onto the screen. Otherwise, the depth of field information is wrong. Figure 99.6 shows the stereo image pair of engine control room use binocular parallel projection algorithm.

99.3.3 Modeling and Maneuvering of the Engine Room Virtual Scene

Engine room virtual scene is a typical complex indoor scene, in which contains main engine, diesel generators, separators, steering gear, fresh water generator, air compressors, propeller, tanks, pumps, various piping and valves. Every equipment consists of many accessories. For reconstructing real scene and making sense on teaching practice, we need model finely and use many photographs as maps. The engine room model mentioned in this paper has four million polygons. To ensure the overall frame rate more than 25FPS during rendering, the following optimization method is taken.

1. Divide the virtual scene into 12 sub-scenes by real ship layout, sub-scene connected with each other by port which called watertight doors in real engine room. Before entering a new sub-scene, the graphics engine first unloads the old sub-scene resources, and then load the new sub-scene resources.

2. As regards equipments which have complex structure and small size, such as diesel generators, separators, air compressors, pumps and valves, we can create multiple levels of detail (LOD) model for them, to form the engine room scene LOD visual database. When the observer is far away from these equipments, simplified model in LOD which does not have groove, screws and thread detail is called for rendering. This method can effectively control the scene complexity and accelerate graphics rendering. However, this method is invalid for large equipment such as main engine. Because of engine room space constraints, the distance between observer and large equipment changed little.
3. Detach all the modifier in modeling tool and delete inner polygons as many as possible for the model those don't need interaction. As for interactive 3D entities, their models' inner structure cannot be deleted for animation purpose. Here we can reduce model segments when modeling. As a matter of experience, circle segments controlled between 8 to 12 is reasonable.
4. By multichannel parallel drawing, reduce rendering load of single PC, accelerate graphics drawing.

Engine control room scene on Fig. 99.6 has many control panels which contains various buttons, switches, and breakers. These 3D entities can operate in virtual scene by mouse. Each operational point encoded by sub-scene, area, interactive type. Simulation results of mathematical model were corresponding with virtual objects by these codes. The entire engine room scene has 3000 operational point. To facilitate the 3D pick-up, some invisible bounding boxes set on the surface of the panel. When the mouse moves to the top of bounding box, it is visible as wireframe. By clicking it, camera will automatic move to front view of the panel. Thus we can easily view and operate panel components.

Development environment used in this paper is as follows, 6 PC with Intel I5 CPU, 4G memory, NV GT250 graphic card. Software development platform is VS.NET and Virtools. Modeling software is 3dmax. Engine room simulation kernel module and mimic simulation module are written in C# language. Graphics engine in visual simulation module is Virtools. Communication block in visual simulation module is written in C++ language and embedded into Virtools in the form of the Buildingblock. 3D model interaction logic is realized by Virtools script and its SDK which is written in C++ language. The two-dimensional array in Virtools is the database which stores the received simulation result.

99.4 Conclusion

This paper describes the CAVE based marine engine room simulation system architecture, gives the hardware configuration and software module planning. The function of each module and the concerned technologies is introduced. Three key technologies including the multichannel synchronization mechanism, stereo vision algorithm, modeling and maneuvering of the engine room virtual scene is analyzed in detail. The implementation ways of them are given. The software modules mentioned in the paper have successfully applied to the development of multi-channel engine room virtual simulation system. The system provides a lifelike environment to experience the real ship, saves the crew training costs. By the design of multichannel parallel drawing, front buffer processing, we make it possible to apply the economy projector and PC on CAVE, save the CAVE hardware costs. The designed CAVE system will play an important role on the development of interactive 3D device, control system design, prototype design discussions, and 3D visualization of data.

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Chapter 100
Countermeasure Research on Strengthening the Tax Administration of Network Trade

Wen-yi Dong and Yang-fan Zhang

Abstract Along with the electronic commerce growing rapidly, we attach great importance to tax administration of network trade. It is important to ensure the healthy development of China's network trade by figuring out why the tax problems occur and making clear the countermeasures to solve them. Due to its characteristics, such as virtualization, paperless certificates, concealed and easy-to-modify data and borderless transaction scope, there is a more serious and complex information asymmetry problem compared with the traditional trade, these are the roots of all tax problems of network trade. Therefore, this article believes that using a new type of intermediary, namely the cybermediary in network trade, can make taxation information sharing possible, and thereby further settle the tax problems in network trade.

Keywords Cybermediary · Information asymmetry · Information sharing · Network trade

100.1 Introduction

With the rapid development of global integration and the Internet, network trade presents a momentum of vigorous growth as a new revolutionary pattern. Economists generally think that the network trade will be an important power to develop world economic in the future.

China's network trade activities have been increasing since 2008. According to related survey data of China's B to B (Business to Business) research center, the amount of our country medium-sized or large e-commerce (electronic commerce) sites have reached 12,282 by June, 2009. Among them, there are 5,320 B to B network service enterprises, B to C (Business to Customer), C to C (Customer to

W. Dong (✉) · Y. Zhang
School of Business, Shandong University (Weihai), Weihai, China
e-mail: dong_wenyi@yahoo.com.cn

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Customer) and other alternative model enterprises amount to 6,962 (IResearch Internet 2010). It is expected that the number of B to B e-commerce enterprises will have reached 13,500 by the end of 2012.

As the Internet industry develops like a raging fire, the size of China's network trade also hits a new record high, the total of market transaction amount attained 3.15 trillion yuan in 2008, including 3 trillion yuan of B to B, 150 billion yuan of B to C and C to C together. By the end of 2010, the market turnover of B to B had been 3.8 trillion yuan. Based on IResearch additionally, the market size of 2012Q1 China Mobile Internet is up to 15.87 billion yuan, increasing by 167.2 % with a cycle-increase of 18.7 %. In recent years, online shopping has always been on the rise (IResearch Internet 2010). Regardless of the natural growth of the industry, as it were, financial crisis makes a great promotion on the development of China's e-commerce market. The reason is that the financial crisis makes consumers more sensitive to the price, so that the price advantage of online shopping becomes an important factor to attract users.

The network trade which brings a qualitative leap compared to the traditional way, has boosted the process of economic globalization. However, it is also a severe challenge to current tax system and administration. On the one hand, the network trade makes traditional trade volume declining sharply and causes harms to actual tax base; on the other hand, the pace of tax department's information construction is far behind with that of network trade's development, which leads to the new taxation blind area. The collection activities of tax authorities depend on correct and comprehensive information of taxpayers, at the same time, the network trade goes beyond the traditional one no matter in technique or business, this makes the information asymmetry between tax authorities and taxpayers more serious, so as to shake the foundation of the tax administration, resulting in a heavy loss of tax revenues in network trade.

Basically, for the technical characteristics of network trade, there are many problems existed in tax collection and management on the basis of current tax system. In comparison with traditional trade method, the network trade has the following four technical characteristics:

Firstly, virtualization; sellers on the Internet usually appear with virtual identities in invisible places to do business, from negotiating and signing the purchase contracts at the beginning to the final payment, all the activities carry out in a virtual environment, and both sides of the transaction don't come into actual contact with each other at all (Wang 2006). Besides, electronic software and books, as well as the electronic audio and video products and other goods sold online are also virtualized

Secondly, paperless certificates; the most activities of network trade, including releasing information, negotiating, signing contracts or ordering on the Internet and paying, all can be completely finished through the virtual electronic media, consequently the paperless transaction certificates becomes possible.

Thirdly, concealed and easy-to-modify transaction data; virtualization and paperless certificates of the transaction, adding the application of computer encryption technology, enable the network trading data to be easier to conceal and transfer (Xu and Zhang 2000).

Fourthly, borderless transaction scope; the Internet makes the world as a whole, while traders do business via Internet can spread all over the world. Some service products and digital products can easily break through monitoring and restrictions of every country's customs territory in a traditional sense, in the meantime, the range of network trade activities greatly expands and gets rid of the limitation of time and space.

Because of these characteristics above, the network trade has a significant impact upon traditional tax system which designs for traditional trade activities. This impact is among the whole process of tax collection and administration, involving tax registration, documents and books management, tax declaration and inspection. Regarding the new tax avoidance methods in network trade activities, traditional ways of countering tax avoidance seem relatively lagging behind (Ma 2005).

Considering all of these issues above, this article argues that a more serious and complex information asymmetry problem is existed nowadays compared with traditional trade, resulting from the technical characteristics of network trade, this is just the root of all tax problems in network trade. In that way, it can be taken into account that using a new type of intermediary which is cybermediary in network trade to make taxation information sharing possible, this should go far towards solving tax problems of network trade as well, and then setting up a proper mode of taxation appropriate for network trade. All these countermeasures are proposed for the reform of tax collection and administration.

100.2 The Types and Process of Network Trade

100.2.1 The Types of Network Trade

The network trade which is an online trading activity by using both the Internet and mobile network develops based on e-commerce. Judged by the meanings simply, the e-commerce contains the network trade. But in form, e-commerce is through electron with the business purpose while network trade is via the network to do the transaction indeed. In fact, the properties of electron and network are the same. Under general circumstances, the network trade only includes such following three forms, B to B, B to C and C to C. But e-commerce still involves B to G (Business to Government) and many other kinds of forms, as to the generalized Internet application, it covers more forms (Liang and Chen 2000). The target customers of network trade always emerge as consumers, whereas in other forms of e-commerce, they may be completely different. For example, the target customers of B to M are enterprises or sellers of enterprise's products and their workers, other than the ultimate consumers. Obviously, what the network trade emphasizes more is conducting a transaction on e-commerce platform (Shao and Youping 2000).

On the perspective of reality, one specific form which is also the materialization of network trade is online shopping on the lips of people. Nevertheless, it should be explicit that there are apparent differences between network trade and the extension of online shopping. Shopping means buying things, usually the behavior

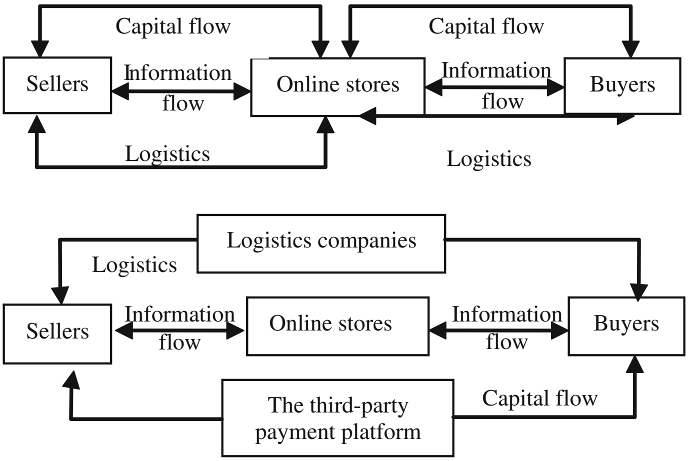

Fig. 100.1 The industry chains of B to C and C to C

of individual consumers, just as same as the online shopping. Let's regard this as standard, from this point of view, so B to C and C to C are the only two basic modes of online shopping. In other words, sellers of online shopping may be either enterprises or individuals, but customers must be individuals (Fig. 100.1).

100.2.2 The Process of Network Trade

The process of network trade includes two types, one is network direct marketing and the other is cybermediary trade.

The network direct marketing is a trading activity between buyers and sellers, taking advantaging of the Internet and related electronic tools. The most prominent characteristics of this way are traders' direct meet via the web, few steps, faster speed and lower costs (Fig. 100.2).

The cybermediary trade is operated through the network commodities exchange centre which is a virtual network market. It binds the goods suppliers, buyers and banks together very tightly based on the Internet by making use of advanced computer software and communication technologies. It offers clients necessary market information, as well as omnibearing services such as commodity trade, storage, delivery and payment (Sun 2009) (Fig. 100.3).

100.3 The Information Asymmetry Problem of Network Trade

Whether in traditional trade or network trade, information asymmetry problem between tax authorities and taxpayers exists to some degree objectively. The key difference between the two is that the network trade uses a large amount of technologic

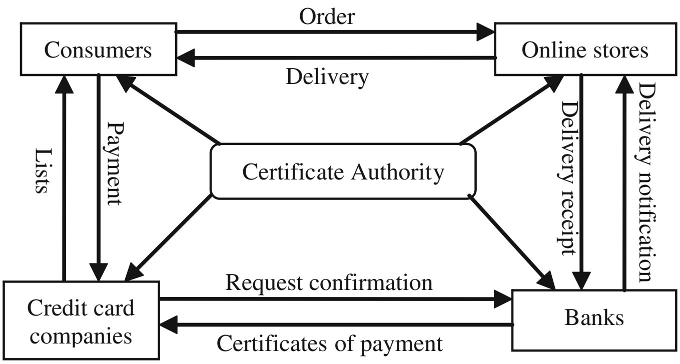

Fig. 100.2 The flow chart of network direct marketing

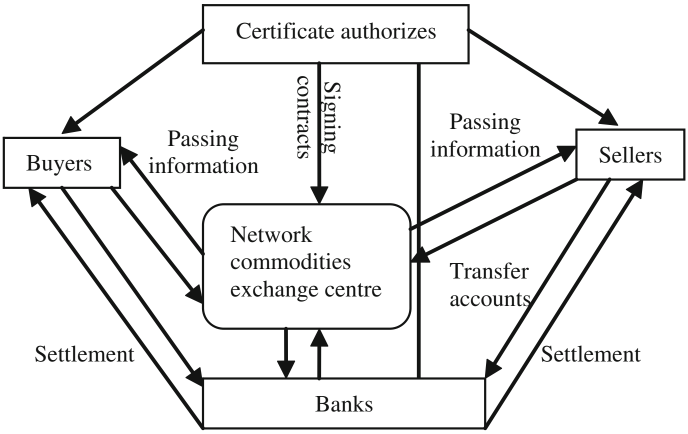

Fig. 100.3 The flow chart of cybermediary trade

information synthetically, having the thoroughly different technical features with the traditional trade (Liu and Cheng 2000). These technical characteristics make it harder for tax authorities to acquire relevant tax information, and then the extent of information asymmetry with taxpayers becomes more severe, consequently resulting in many new operational problems in tax collection and management.

In B to B mode, both trading partners are enterprises which usually have done the tax registration, so tax authorities can get the basic information of taxpayers. The sellers in the administrative scope of tax authorities need to undertake tax declaration and keep books and documents as required. Since the buyers often ask for invoices for tax deduction, thus the online trading can be reflected in the sellers' accounts. Then tax authorities can realize the sales information of sellers through buyers. As a result, tax authorities can get more tax information and the information asymmetry degree is relatively low in this mode (Deng and Liao 2001). While in B to C mode, the buyers may not ask for invoices although the enterprises also do the tax registration generally. This situation makes some enterprises sale out of accounts that do not reflect the online sales in accounts. Even if they have done the tax declaration, the off-book sales is the part not so easy to be inspected to get online trading information by tax authorities. Therefore, tax authorities will get little tax information sometimes and the information asymmetry degree with taxpayers is large in this kind of mode. There are basically two types of sellers in C to C mode. First are the self-employed entrepreneurs who have done the business and tax registrations; they usually have physical stores and sale online because they find the online shop is profitable; the others are the personal or partnership online stores without the business and tax registrations. In order to evade the tax, the former type of sellers usually don't charge the goods sold online to an account, while the latter don't have any administrative examinations and approvals at all. Either of these cases can cause that tax authorities will not obtain their related business information, and the information asymmetry degree becomes extremely large (Jin 2009). Apparently, the tax information asymmetry degree in C to C mode is the largest; especially when individuals don't do tax registrations and tax authorities have no ways to get their information, so the information asymmetry degree reaches the maximum at this time. Whereas the increasing information asymmetry degree will inevitably leads to a decline of the tax administration efficiency, a decrease of tax revenue and an increase of tax loss simultaneously in network trade. When information asymmetry degree is extraordinary severe, for instance, some happened to most C to C online trade at present, the total tax revenue will probably be lost.

Thus it can be seen that, we must tackle the problem that information asymmetry degree between tax authorities and taxpayers is getting bigger, in order to improve tax administration efficiency of network trade and avoid the loss of tax revenue source (Geng 2000).

100.4 The Effects of Cybermediaries on Solving the Information Asymmetry Problems

The network trade omits middle links of a transaction owing to its direct feature; afterwards greatly affect the traditional intermediaries, so that some even disappear. However, as network trade grows vigorously, the cybermediary, a new type of intermediary emerges as the times require and the reintermediation forms as well. In addition, on the perspective of its developing process, transaction costs still exist and intermediaries are needed to provide a trading platform and kinds of services such as payment, credit and evaluation, etc. Hence many traditional intermediaries also begin to use the information network to accomplish their networking transformation. In short, the cybermediaries are the intermediary organizations which utilize the National Information Infrastructure to create economies of scale and scope. There are no essential differences of functions in comparison with traditional intermediaries. The objective of their existence is to drive down transaction costs and enhance efficiency (Yongqing and Binchao 2004).

The cybermediaries can be divided into the following three types. First one, the third-party trading platform, its functions include letting sellers set up online stores at a low-cost, integrating sellers and their products with buyers and their needs, achieving economies of scale and scope, and providing published information, search, pricing, evaluation and other services for both sides of the transaction. The second is the third-party payment platform, namely an online payment platform operated by nonbanking third-party organizations. Its role is to let contracting parties gain interface with the bank payment and settlement system and channel services by means of signing contracts with banks, then make the online payment. Third, the credit intermediary, it widely collects and processes relevant credit information of trading partners by dint of the network information and data analysis techniques synthetically, accordingly generates the information products like trading credit rating.

Many scholars have researched that the tax can be withheld by third-party payment intermediaries, whereas studies on whether tax authorities can get tax information from cybermediaries are few. This article considers that the cybermediaries could become the effective providers of tax information instead of relevant taxpayers, and tax authorities can reduce the increasing degree of information asymmetry with taxpayers by sharing information, for the sake of resolving the challenges brought to traditional tax administration by the emerging network trade.

The cybermediaries makes many positive contributions to the works of tax authorities, as follows.

100.4.1 Provide the Required Information for Tax Collection

The three types of cybermediaries, all can help tax authorities confirm the taxpayers' vague identities and tax payment places which are not certain at all, and then incorporate online operators into the taxation scope, this is the premise of levying taxes on network trade,.

100.4.2 Reduce the Acquisition Costs of Tax Information

Assuming n is the number of online traders, C_A and C_a respectively represents the acquisition costs of each taxpayer's information incurred by tax authorities and cybermediaries, and C represents the costs of obtaining information by tax authorities directly from cybermediaries. In that way, the total costs are nC_A in the circumstance that tax authorities get information directly from taxpayers. So when n is very large, $nC_A > C$ is sure to know, it means that tax authorities can lower acquisition costs of information through cybermediaries. Moreover, total information costs of whole market are $C + nC_a$ when tax authorities take good advantage of cybermediaries. As the cybermediaries involved in the deal have preserved related information, their acquisition costs of information C_a is lower than C_A inevitably, when n is very large, it is undoubted that $C + nC_a < nC_A$. In view of these, we can conclude that it is because of cybermediaries' participation that the taxation costs of whole market can be driven down.

100.4.3 Enhance the Efficiency of Tax Collection and Administration

Considering shared information, the cybermediaries themselves can be regarded as a signal of taxpayers' type. They commendably aid tax authorities in judging different taxpayers' types when they carry out inspections. Some scholars' relevant studies have shown that, if the correlation between shared information of cybermediaries and taxable incomes of taxpayers is high enough, the cybermediaries can help tax authorities enhance the efficiency of tax collection and administration indeed (Li et al. 2004).

100.5 Related Supporting System

Evidently, legal issues have to be addressed at first if tax authorities want to reduce costs and improve efficiency through sharing information with cybermediaries. Without restrictions imposed by law, the cybermediaries will not cooperate with tax authorities voluntarily, and share the information of taxpayers and related transactions. They may suffer adverse consequences owing to their unilateral behavior of sharing information, not only including a decreasing number of users which means the dropping market share, but also declining profits.

100.5.1 Clear the Obligations of Cybermediaries to Report Information

Within the existing framework of Tax Collection, there are specific laws clearly stipulating the cybermediaries' obligations of reporting information and details. Corresponding penalties are formulated for punishing those cybermediaries which refuse to report related tax information or present false information deliberately, also should be earnestly implemented. This is not only the first step to make an effective solution, but also the major premise for cybermediaries to give a full play to their roles in tax collection and administration.

100.5.2 Implement the Real-Name Registration System of Network Trade

Because there are flexibility, virtualization and other characteristics of network trade, so even if tax authorities find the tax evasion of some operators from the information provided by cybermediaries, these operators still can escape the possible punishments by changing their false identity online. It is thus clear that the implement of real-name registration system is a powerful guarantee for tax authorities to use information effectively provided by cybermediaries. Under the current circumstances of our country, it has achieved the real-name system of two parties to a trade in B to B mode, yet the other two kinds of e-commerce modes which are B to C and C to C only require the sellers to register with their real names. China began to carry out the "Provisional Administration Method of Network Commodities Trade and Services" since July 1st, 2010, which stipulated that the natural persons engaged in commodity trades and services through the website should apply to the providers of network trade platform, and submit some information about real identity like name, address and so on. The policy also showed that our country entered a new period of pursuing the real-name registration system.

100.5.3 Set up the Inspection Institution Against Intermediate Trading System

Needless to say, cybermediaries have the economic motivation of helping both buyers and sellers to evade tax. Furthermore, on account of the paperless and encrypted technical characteristics of network trade itself, the cybermediaries are more likely to tamper the trading records. As a result, the trading software system used by cybermediaries' companies should be the focus of the inspection, tax authorities can set up the whole and normative inspection institution against the trading system used by these companies relying on new established technical measures.

100.6 Conclusion

The influences on international tax and the international tax policies of the network trade are omitted from this article for reasons of limited space. Throughout the taxation theories and policies about network trade of international organizations, regional groups and countries, we can reach a consensus nowadays; taxation in network trade should be based on the fact that it will not distort the economic environment and behaviors of taxpayers. However, it is still lack of more in depth researches in network trade about how to prevent a large drain on tax revenues, perfect the current tax system and change the existing modes of tax collection and inspection, etc. Besides, there are serious disagreements among countries yet, for example, whether to impose "bit tax", if the scope of value-added tax should be expanded to network trade, how to divide the tax jurisdiction, and the problem of applicability on international tax concepts like permanent organ and so on. Predictably, it will be a long and complicated process of tax policy's study and international tax coordination on network trade (Zhao 2011).

As China's e-commerce starts late, especially network trade, scholars for the most part don't advocate imposing some restrictions on it in its first flourishing couple of years. They believe that loose policies are essential, particularly on taxes for purpose of closing the gap with developed countries as soon as possible, which are also the strategies for a potential source of tax revenues in the future.

Thereby this paper suggest that, the initial stage of network trade will pass and its scales continue to expand, after all, untaxed network trade goes against the tax principles of justice and efficiency, and also have a negative impact on the fairness of commercial competition. Therefore, levying taxes on online stores is the wave of the future, we need to study carefully and get prepared for it amply at present. In the long run, the low price, because no tax is paid, can not be the core competence of online stores for a long time. Eventually, it has to upgrade the qualities of products and services to achieve the sustainable and healthy development of network trade; only in this way can it form a win-win situation between consumers and business operators.

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Chapter 101
Developing a New Foot Shape and Size System for Taiwanese Females

Yu-Chi Lee, Wen-Yu Chao and Mao-Jiun Wang

Abstract This study aims to use 936 females' 3D foot anthropometric data to cluster foot shapes and to develop a new sizing system. Twelve-foot dimensions including foot length, ball of foot length, outside ball of foot length, foot breadth, heel breadth, ball circumference, instep circumference, toe height, arch height, instep height, toe 1 angle and toe 5 angle were collected. The PCA results indicated that foot breadth, foot length and arch height were selected as the three principal components. The percentage of total variance explained by the 3 principal components was 76.65 %. Using K-means clustering can classify female subjects' foot into 3 foot types. The new sizing system had less number of sizes, high coverage rate and provided updated foot dimensions as comparing with the current sizing system (CNS 4800-S1093). The manufacturer can apply these results for shoe last design and footwear production with better fitness and less production cost.

Keywords Clustering analysis · Foot dimensions · Foot shape classification · Sizing system

101.1 Introduction

Wearing improper footwear increases the risk of foot problems, for instance, corns, ankle injury, chronic pain or blister of foot (Killian et al. 1998; Ayub et al. 2005). For shoes manufacturing, the shoe last plays an important role on representing the

Y.-C. Lee (✉) · W.-Y. Chao · M.-J. Wang
Department of Industrial Engineering and Engineering Management,
National Tsing Hua University, Hsinchu, Taiwan
e-mail: liyuchi1113@gmail.com

M.-J. Wang
e-mail: mjwang@ie.nthu.edu.tw

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human's foot shape characteristics, as well as increasing the wearing fitness. Using anthropometric data for footwear design can increase the fitness. To investigate individual factors, such as gender, demographic data and habits, affecting the foot shape are helpful for shoes and last designing. For gender effect, most of references were reported that males have greater foot dimensions than females (Krauss et al. 2008; Xiong et al. 2009; Voracek et al. 2007), but few studies have reverse results in foot breath (Luo et al. 2009; Salami 2009). These studies were conducted in different area, and the ethnic differences might be a reason to interrupt the inconsistent results (Hawes et al. 1992). That is, different nations should investigate their own characteristics of foot shape and to develop shoe sizing system.

Foot shape classification has been investigated by using different approaches. Razeghi and Batt (2002) reported that the method of foot type classification based on foot morphology using visual assessment, footprint parameters and anthropometric values. Visual assessment is an easy method for evaluating the structure and alignment of the foot, especially when clinicians diagnosed the abnormality feet. By applying visual method, Dahle et al. (1991) reported that a 73.3 % agreement in the assignment of the evaluated feet into three groups, i.e. pronated, supinated and neutral foot types. For using footprint parameters to classify foot shapes, the arch index (Cavanagh and Rodgers 1987) was commonly applied. Nikolaidou and Boudolos (2006) used different indices calculated from footprint and K-means cluster analysis to obtain individual classifications. Using anthropometric data was another way to characterize foot shapes. Some studies measured food dimensions directly by using manual method (Cheng and Perng 1999; Gong et al. 2010) and some other studies collected foot dimensions by using 3D scanning systems for different age groups such as children (Mauch et al. 2009) and adults (Krauss et al. 2008), and classified the foot in different types. A study collected 20,000 children with age ranging from 4 to 17 years old using 3D foot scanner and found that the foot dimensions showed a gradual increase by age (Ran et al. 2011). Moreover, Hong et al. (2011) collected foot dimensions of 1,236 Chinese young adult men and 1,085 women by using 3D scanning method and indicated that foot width, medial ball length, ball angle and instep height showed significant differences among foot types in the same foot length for both genders.

The foot length, foot breadth, heel breath, ball girth, toe girth, waist girth, instep girth, toe height and instep height were the 9 of the frequently used foot dimensions for producing shoe last. By using these foot dimensions, one can cluster the foot in several foot types and build the sizing system (Szirovicza and Tucakovic 2003). The current shoes sizing system in Taiwan (CNS 4800-S1093 2000) cannot fill the customers' need, because this standard is mainly adopted from the Japanese standard (JIS S-5037 1998). There exist intrinsic foot shape differences between people in different countries as well as generations (Mochimaru et al. 2000). Cheng and Perng (1999) collected 2,486 adult male samples in Taiwan, and indicated that the foot length and ball girth were the important dimensions affecting shoe last design and a foot sizing system was also developed. A good foot sizing system can be very helpful for shoes and last manufacturing, as well as increase the wearing fitness. The previous study was conducted in 1999. The generation effect has influenced the anthropometric data (Mochimaru et al. 2000). Thus, it is necessary to develop a new sizing system with updated foot dimensions. In addition, the use of 3D scanning technique was more precise and accurate than the manual measuring method. There is little information about using 3D scanning data to cluster the Taiwanese females' foot shape. Hence, the objective of this study was used the 3D foot anthropometric data of Taiwanese females to cluster the foot shapes by using PCA and two-stage cluster analysis, and to develop a new sizing system.

101.2 Methodology

101.2.1 Data Preparation

A total of 936 Taiwanese female's right foot dimensions were used in this study. The database was conducted from February 2007 to June 2009. The age of the subjects ranged from 20 to 60 years, the mean age was 32.85 ± 9.93 years old. The mean stature was range from 140 to 185 cm and body weight ranged from 38 to 90 kg. The mean of stature and body weight was 160.72 ± 5.89 cm and 54.39 ± 8.16 kg, respectively. None of them had any history of visible foot abnormalities or foot illnesses.

A 3D foot scanning system was used to collect foot dimensions (INFOOT USB scanning system, IFU-S-01, I-Ware Laboratory Co., Ltd, Japan). The 3D foot scanner has 8 CCD cameras and 4 laser projectors to construct the structure of foot. The accuracy of the foot scanner was within 1.0 mm (Kouchi and Mochimaru 2001).

Before data collection, all the participants were asked to wash their feet. This procedure can avoid the particles on foot surface to influence the scanning quality. At the beginning, an experimenter placed 2 anatomical markers on the subject's foot. The positions of the 2 markers were 1st and 5th metatarsal head. The markers can enhance the precision of scanning data and help the scanning system to automatically measure foot dimensions. Twelve foot dimensions including foot length, ball of foot length, outside ball of foot length, foot breadth, heel breadth, ball circumference, instep circumference, toe height, arch height, instep height, toe 1 angle and toe 5 angle were collected. These anthropometric dimensions are commonly used in footwear design. The definitions of the foot anthropometric dimensions were the same as ISO 7250 (2004).

Each subject was asked to scan twice with a natural standing posture without support. The body weight distributed evenly on medial and lateral side. It took about 10 s to complete one scanning. In order to ensure the scanning image quality, feet and body swings during scanning was minimized. Statistical analysis was done by using SPSS 13.0 software.

101.2.2 Factor Analysis

Factor analysis is a multivariate statistical analysis method that estimates the inter-relationships among a large number of variables and calculates the underlying factors. In this study, the principal component analysis (PCA) was applied to obtain important factors for foot shape representation. The factor scores calculated by factor analysis were used for classifying the foot shape into several foot types.

101.2.3 Cluster Analysis

A two-stage cluster analysis including hierarchical and non-hierarchical methods was performed to classify foot types. The Ward's minimum variance method was used to determine the number of clusters for the hierarchical approach. Subsequently, the K-means cluster analysis was used to cluster the homogeneous individuals into groups for the non-hierarchical approach. The result of cluster analysis can be considered as a typical foot shape.

101.3 Results

101.3.1 Results of Principal Component Analysis

By using Kaiser's eigenvalue criterion, factors with the eigenvalue exceed 1.0 were selected (Kaiser 1960) as principal component. Figure 101.1 is a scree plot of the principal component, ordered by eigenvalues. As Fig. 101.1 shows that the slope was flat and close to zero after the fourth factor and indicates that selecting 3 principal factors is adequate. Table 101.1 shows the results of PCA for foot dimensions. There are only 3 principal component's eigenvalue greater than 1. The percentage of total variance explained by the 3 principal components was 76.65 %.

The dimensions select as principal component 1 were breadth-related variables, including ball circumference, foot breadth, instep circumference and heel breadth. Thus, component 1 was named as girth factor. Similarly, component 2 and 3 was named as length factor and height factor, respectively. Subsequently, a two-stage cluster analysis was performed for the classification of foot shapes. The variable with highest factor scores of each principal component had first priority to consider as independent variable for cluster analysis. The ball circumference, outside ball of foot length and arch height dimensions had the highest value in each principal component. In general, researcher would consider the real situation such as customer buying behaviors, to select the useful dimensions to further analysis. In this study, foot breadth, foot length and arch height were selected as the three principal components for clustering analysis.

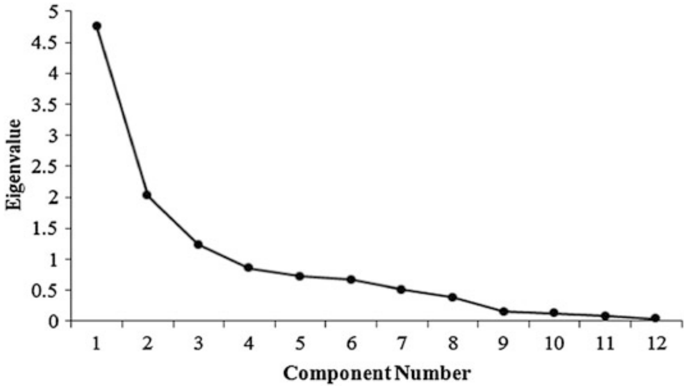

Fig. 101.1 Scree plot of principal component analysis results

Table 101.1 Results of principal component analysis for female foot dimensions

Foot dimensions	Principal component		
	1	2	3
Ball circumference	0.928		
Foot breadth	0.887		
Instep circumference	0.882		
Heel breadth	0.698		
Outside ball of foot length		0.923	
Ball of foot length		0.911	
Foot length		0.873	
Arch height			0.808
Instep height			0.772
Toe height			0.599
Toe 1 angle			−0.575
Toe 5 angle			0.473
Eigenvalue	4.757	2.023	1.236
Variance explained (%)	45.51	19.84	11.30
Cumulative %	45.51	65.35	76.65

101.3.2 Foot Shape Classification

From the results of two-stage cluster analysis, three clusters were extracted. Figure 101.2 illustrates the distribution of arch height (z-axis) vs foot length (x-axis) vs foot breadth (y-axis) for all three clusters. The cluster with 157 samples having short foot length, short foot breadth and low arch height was defined as S type. The cluster with 517 samples having medium size in three principle dimensions was defined as M type. Similarly, L type with 262 samples was identified with long foot length, wide foot breadth and high arch height.

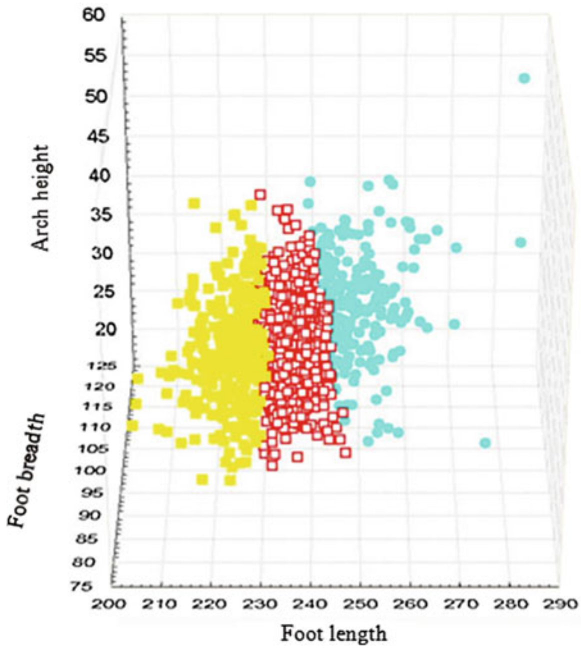

Fig. 101.2 The scatter plot for the three foot types. (unit in mm)

In here, the Euclidean distance method was applied to find out the figure type of each group. The three principal dimensions of the three figure foot types and represented in Table 101.2.

Using foot length and arch height dimensions can classify females' foot shape into three types, including S: foot length lower than 231 mm with arch height <40 mm; M: foot length between 231 and 243 mm with arch height <40 mm; L: foot length exceed 243 mm with arch height >40 mm. Table 101.2 also shows that the proportion of each foot type. The highest proportion was 55.2 % of M type, followed by L (28.0 %) and S (16.8 %) type. The S foot type was short, narrow with low arch height, and the L type foot was long and wide with high height.

Table 101.2 Foot dimensions and distributions of the 3 foot types

Terms	Foot type		
	S	M	L
Foot length (mm)	226	239.8	248.1
Foot breadth (mm)	90.2	93.5	95.9
Arch height (mm)	37.0	36.2	42.4
Proportion	16.8 %	55.2 %	28.0 %
Scope of foot length (mm)	<231	231 ～ 243	>243

101.3.3 Developing the Sizing System

According to CNS 4800-S1093 (2000), the control dimensions for footwear sizing were foot length and foot breadth. The size interval for foot length was 5 mm and for foot breadth was 4 mm. Here, we followed this rule to develop a foot sizing system based on the results of cluster analysis. Figure 101.3 illustrates the foot sizing system for the Taiwanese males. In this system, for foot length, with an interval of 5 mm, 14 subgroups were obtained. For foot breadth, with an interval of 4 mm, 9 subgroups were obtained. We also gave the each size a label. This size label can help the customers to find the right shoe size easily. For the size label applied in this study, for instance S220-85, it means that this size is suitable for the small figure type with foot length between 215 and 220 mm and foot breadth between 81 and 85 mm (Chung et al. 2007).

101.4 Discussion

In here, the newly developed sizing system was compared with the current shoe sizing system in Taiwan, CNS 4800-S1093 (2000). This sizing system was based on foot length with 5 mm size interval and foot breadth with 1 or 2 mm size interval. There are 9 foot shapes named as A, B, C, D, E, EE, EEE, EEEE and F. For the newly developed sizing system, 5 mm interval for foot length and 4 mm interval for foot breadth were used for sizing, and 3 foot types (S, M and L) are classified. Table 101.3 presents the results of the new sizing system and the CNS 4800-S1093 sizing system. The coverage of each foot type in the new sizing system was 33.6 % (S type), 40.2 % (M type) and 19.0 % (L type). For the CNS 4800-S1093 sizing system, the coverage of each foot type was also shown in

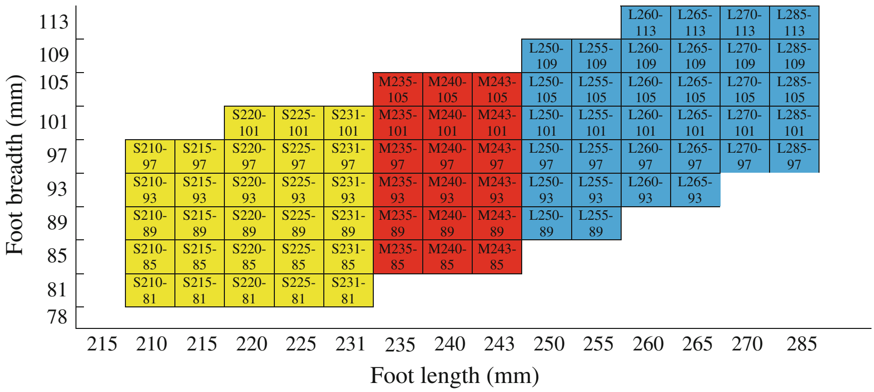

Fig. 101.3 A new sizing system developed in this study

Table 101.3. As we can see, the total coverage was 92.7 % and 98.7 % for new sizing system and the CNS 4800-S1093 sizing system, respectively. Moreover, the number of size groups for the new sizing system was 80 and for the CNS 4800-S1093 system was 144. The higher coverage of the population, the less number of sizes and the better fitness are the three main criteria for evaluating an effective sizing system. McCulloch, Paal and Ashdown (McCulloch et al. 1988) indicated that it is almost impossible to have a perfect sizing system, owing to the three criteria are in compromising conflict. To compare the results between the new sizing system and the CNS 4800-S1093 system, the lower coverage and less number of sizes was found in new sizing system. There is only 6 % difference of total coverage between two sizing system but the number of sizes is quite different (80 vs. 144). For shoe manufacturing, the number of sizes indicates the number of shoe lasts was needed. Thus, it might increase the cost and complexity of production. Using CNS 4800-S1093 sizing system to product shoes might inefficient due to with higher coverage but a large number of sizes are followed.

Moreover, the subjects of this study aged from 20 to 60 years. Ran et al. (2011) used the 3D foot anthropometric data to cluster the feet of Chinese children and reported that the significant differences in foot length and foot breadth were found between children aged from 13 to 17 years. That is, the foot dimensions increased with increasing age up to 17 years old. The CNS 4800-S1093 sizing system is specified for Taiwanese adults aged over 12 years. The young boys' foot anthropometric data were included in the CNS 4800-S1093 sizing system. To compare the range of foot length and foot breadth between the new sizing system and the CNS 4800-S1093 sizing system, the smaller foot length and foot breadth dimensions were observed in CNS 4800-S1093 sizing system (see Fig. 101.4). The foot anthropometric data of the CNS 4800-S1093 sizing system included 12–17 years-old subjects. This perhaps explains the fact that the smaller foot length and foot breadth dimension found in the CNS 4800-S1093 sizing system as comparing with the new sizing system.

Table 101.3 The summarized results of the new sizing system and the CNS 4800-S1093 sizing system

Sizing system of this study			CNS 4800-S1093		
Category	No. of sizes	Coverage (%)	Category	No. of sizes	Coverage (%)
			A	16	5.9
			B	16	12.5
			C	16	17.5
S	28	33.6	D	16	16.9
M	18	40.2	E	16	21.4
L	34	19.0	EE	16	11.3
			EEE	16	8.3
			EEEE	16	3.4
			F	16	1.4
Total	80	92.7		144	98.7

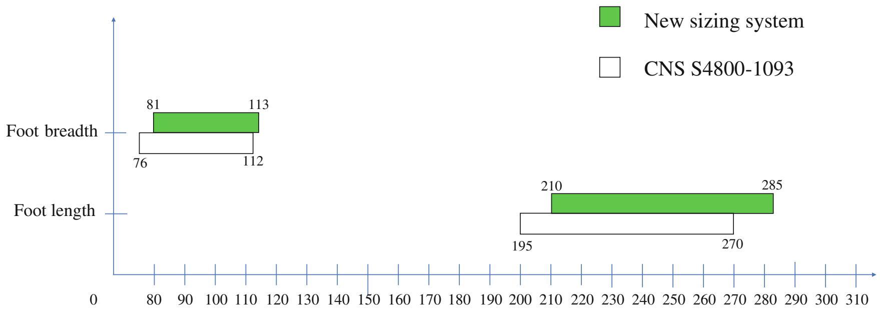

Fig. 101.4 The comparison of the new sizing system and CNS S4800-1093 sizing system in foot length and foot breadth range (unit in mm)

In addition, it is interesting to note that the foot data used in this study had greater foot length and breadth than that of in the CNS 4800-S1093 sizing system (as shown in Fig. 101.4). The CNS 4800-S1093 sizing system is mainly adopted from the Japanese sizing system (JIS S-5037 1998) which was developed in 1998. The current shoes sizing standards in Taiwan cannot meet the user's needs. There exist intrinsic foot shape differences between people in different countries.

101.5 Conclusion

This study used a two-stage cluster analysis approach to classify foot shapes and to develop a new foot sizing system for the Taiwanese females. Using foot length, foot breadth and arch height can classify the female's feet to 3 typical foot types with 76.65 % total variables explained. The new sizing system had high coverage (92.7 %) and less number of sizes (80 sizes). Although the CNS 4800-S1093 sizing system had higher coverage (98.7 %), a large number of sizes (144 sizes) are followed. The results indicated that the CNS 4800-S1093 shoes sizing standards cannot meet the female Taiwanese's foot. This study developed a new sizing system and provides very useful information for the footwear production planning, product design and manufacturing.

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Chapter 102
Exploring User Experience Measurement of Location-Based Service Applications

Jun Zhuo, Danyang Huang and Ying Chen

Abstract Based on literature review, this study proposed a scale of user experience measurement of location-based service applications. The scale is validated empirically using 363 valid samples by questionnaire and online survey, making use of SPSS 18.0 software. The final scale is consisted of 39 items under five dimensions, useful, ease of use, efficiency, creditable, satisfaction. With this scale, we will have a better knowledge of user experience and then strive to improve it.

Keywords GPS · Location-based service · Measurement scale · User experience

102.1 Introduction

Location-based services represent an emerging class of computer systems providing mobile device users with information and functionality related to their geographical location (Paay and Kjeldskov 2008). The Location-based service applications are defined as: a mobile value-added services that individual users use LBS mobile application software to locate, then use all kinds of information and services around by software operation.

Within recent years, this class of context-aware mobile computer systems has received increasing attention from researchers within a range of computer science disciplines as well as from industry. Location-based services open a new market

J. Zhuo (✉) · D. Huang · Y. Chen
Department of Management, Zhejiang University, Hang Zhou, China
e-mail: zju-zhuojun@163.com

D. Huang
e-mail: dan.yang1990@163.com

Y. Chen
e-mail: zxt115@163.com

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for network operators and service providers to develop and set up value-adding new services for users on the move, such as helping find nearby shops or friends, advertising traffic conditions, supplying routing information. Recent advances in technology have uptake of a wide range of location-based services. PDAs and 3G mobile phones with GPS and other positioning capabilities have become increasingly affordable and popular.

Location-based service (LBS) industry has entered a period of rapid growth in China and the LBS industry is extremely competitive. On the Tenth China Internet Conference, the insiders and experts in related fields agreed that, LBS will become the standard configuration of the whole industrial application in the Mobile Internet era, and most likely to become the first ten billion scale 3G mobile internet applications. However, in the long run, not every developer and operator can achieve long-term survival and maintain sustained profitability. Therefore, how to measure their experience from a user perspective, and then to improve the shortage to enhance the user experience is the focus of the developers and operators.

Contributing to this research, this article reviewed the previous studies about how to measure user experience firstly. Then, we put forward a scale for measuring the level of user experience in LBS. Finally, through the questionnaire survey we test the validity and reliability of the scale.

102.2 Literature Review

To understand the related research of the user experience and location-based service applications, this study has combed the domestic and foreign literatures. EBSCO and Web of Science database as the representative of foreign literatures and China National Knowledge Infrastructure and Weipu database as the representative of domestic literature. The retrieval method is generally in accordance with the Title/Keyword search, we deleted some obviously not related areas, such as health care and rehabilitation, and news, letters and other types of articles were removed, specific search results are shown in Table 102.1.

Table 102.1 Search results of domestic and international representative databases

Data source	Topic/key words			
	User experience	User experience + measure/ measurement	Location-based service	Location-based service + user experience
Web of science	2,021	176/116	366	6
EBSCO	1,923	90/49	75	2
CNKI	3,551	1	12	0
Weipu	1,022	0	0	0

The search results reveal that literatures about the user experience of location-based services are not many, the research about it is still in the initial stage. However, if the LBS developers and operators want to succeed, they must know the extent of the user experience. Therefore, research of measuring the user experience of LBS applications is very necessary.

In Human–Computer Interaction (HCI) field, measurements have traditionally been usability measures (Ketola and Roto 2008), ISO 9241-11 determined the three aspects of usability, usability is defined as “The extent to which a product can be used by specified users to achieve specified goals with effectiveness (accuracy and completeness), efficiency (resources expended, how quickly a user can perform a task) and satisfaction (the extent to which expectations are met) in a specified context of use” (ISO 1998). People put forward many dimensions to measure usability, such as learnability, memorability, error prevention, and satisfaction (Nielsen 1993); effectiveness, learnability, flexibility, and attitude (Shackel and Richardson 2001); guessability, learnability, experienced user performance, system potential, and re-usability (Jordan 1998). And some people developed some relevant questionnaire (Table 102.2).

When usability evolved to user experience, the measurements broadened from pragmatic (easy and efficient) to experiential (delighting) (Hassenzahl 2003). Bevan (2008) suggested that the concept of usability at the system level can be broadened to include learnability, accessibility and safety, which contribute to the overall user experience. Jordan (2002) upgraded his list to functionality, usability, pleasure, and pride. Norman (2002) set the goal in engaging users in visceral, behavioral, and reflective level. Tullis and Albert (2008) argued measurement of the user experience can be attributed to two main areas: performance and satisfaction, then put forward five main measurement dimensions: task success, task time, error, efficiency, ease of learning.

As UX highlights the emotional aspects, also emotion measurements have been investigated. Most emotion evaluations concentrate on experience :identifying the emotion a user has while interacting with a product, and both objective and subjective methods are used to collect this information [e.g. Mandryk et al. (2006); Desmet and Overbeeke (2001)].

Table 102.2 Questionnaires measuring the usability

Questionnaire name	Developers	Time
The Question-naire for User Interaction Satisfaction (QUIS)	Chin, Diehl, and Norman of the University of Maryland	First published in 1988, and continuously updated.
The Computer User Satisfaction Inventory (CUSI)	Kirakiwski and Corbett	1988
Software Usability Measurement Inventory (SUMI) (Cavallin et al. 2007)	Human Factors Research Group (HRFG) of the University College Cork	First published in 1993, and continuously updated.
The Software Usability Scale (SUS) (Brooke 2004)	Brooke	2004

Table 102.3 Element of user experience

Element	Implication	Theory support
Useful	The extent to which the system can help users complete a task	Peter Morville (http://semanticstudios.com/publications/semantics/000029.php)
Ease of use	The easy-to-use level	SUS
Learnability	The difficulty of learning to use the system for the first time	QUIS
Creditable	The level of users' trust of the system	Bevan (2008), Peter Morville
Accessibility	The degree of usability in use for users with specified disabilities	Peter Morville, Nigel Bevan.
Satisfaction	The extent to which expectations are met	ISO/IEC CD 25010.2 (2001), Peter Morville
Controllability	The extent to which the user is satisfied that the product will behave as intended	Shneiderman and Plaisant (2002)

Based on the pase theory about user experience and usability measurement, we summed up the following constituent elements of user experience (Table 102.3).

102.3 Scale Development

102.3.1 Scale Development Theory and Process

This study will base on the traditional scale development paradigm, proposed by Churchill (1979), this scale development processes are as follows:

Step 1: Literature review, gain a clear idea of the concepts and content of LBS applications.

Step 2: Develop an initial scale, and make improvements through group interviews and interviews with experts.

Step 3: Conducted a questionnaire survey of the revised scale.

Step 4: Obtain the most simple scale (check the alpha coefficient, conduct exploratory factor analysis)

Step 5: Conduct the confirmatory factor analysis and validity test of the final scale.

Step 6: Determine the formation of the final LBS applications user experience measurement scale.

Table 102.4 Scale and initial items of lbs user experience measurement

Dimension	Serial number	Items	References
Useful	T1	The LBS application improves my efficiency of work	Lund (2001) USE, Doll and Torkzadeh (1988), this study
	T2	The LBS application is useful	
	T3	The LBS application saves my time	
	T4	The LBS application makes it easier to complete my task	
	T5	The LBS application makes me better control the activities of life	
	T6	The LBS application provides me enough information	
	T7	Information the LBS application provided is accurate	
	T8	Information the LBS application provided is the latest	
Ease of use	T9	The LBS application is ease to use	Lund (2001), SUMI, this study
	T10	Operate the LBS application is simple	
	T11	The LBS application provide the least steps to my task	
	T12	The way the LBS application provide information is transparent	
	T13	I learn how to use the LBS application very fast	
	T14	The LBS application provide abundant help and instructions	
Efficiency	T15	The LBS application's response speed is very quickly	SUMI, this study
	T16	The LBS application downloads and installs very quickly	
	T17	The LBS application generated little error	
	T18	The LBS application updates and upgrades timely and effective	
	T19	The LBS application determines the location very accurate	
	T20	The LBS application is sensitive to the change of location	
Creditable	T21	Use the LBS application software, my personal information will not be leaked to others	Wells et al., this study
	T22	The LBS application protect my important information	
	T23	I have confidence about the LBS application's ability to protect my personal information	
	T24	Use the LBS application software, I think my personal privacy is not in danger	

(continued)

Table 102.4 (continued)

Dimension	Serial number	Items	References
Controllability	T25	The LBS application won't suddenly collapse	SUMI, this study
	T26	The LBS application switch from one task to another very easy	
	T27	The LBS application can precisely execute what I want it to do	
	T28	Use the LBS application software, it's easy to revoke wrong operation	
Satisfaction	T29	I am satisfied with the LBS application	Hassenzahl (2003), Nokia 2008, this study
	T30	I will introduce the LBS application to my friends	
	T31	It is very interesting to use the LBS application	
	T32	The LBS application work in the way I hope	
	T33	I need to have the LBS application	
	T34	Use the LBS application make me happy	
	T35	Use the LBS application makes me feel very proud	
	T36	I think people who never heard of the LBS application is outdated	
	T38	The expense of using the LBS application is reasonable	
	T39	The LBS application meets my expectations	

102.3.2 The Generation of Initial Items

In this paper, we collect the initial items mainly through reading before scholars' research literature. In addition, I conducted two focus group interviews, focus group members are regular users of LBS applications. I request them to submit their most important dimension and content of the LBS application software. At the same time, we consulted the experts to further collection of the initial questions.

Based on the above work, we classified all items under seven initial dimensions (Table 102.4).

102.3.3 Scale Purification

We collected the data of scale purification through three channels: first, we sent the questionnaires to our friends; secondly, questionnaires are issued in the library;

Table 102.5 The result of reliability statistics and the CITC statistical analysis

Dimension	Serial number	Before item purification		After item purification		Cronbach's alpha
		Corrected item-total correlation	Cronbach's alpha if item deleted	Corrected item-total correlation	Cronbach's alpha if item deleted	
Useful	T1	0.717	0.842	Stay the same		0.872
	T2	0.724	0.841			
	T3	0.769	0.833			
	T4	0.627	0.859			
	T5	0.569	0.867			
	T6	0.640	0.855			
Ease of use	T7	0.584	0.878	Delete		0.875–0.878
	T9	0.771	0.832	0.774	0.774	
	T10	0.751	0.837	0.753	0.753	
	T12	0.710	0.847	0.690	0.690	
	T13	0.711	0.847	0.728	0.728	
Efficiency	T8	0.575	0.810	Delete		0.804–0.810
	T16	0.665	0.716	0.683	0.683	
	T18	0.718	0.665	0.683	0.683	
Creditable	T17	0.661	0.907	Stay the same		0.914
	T21	0.742	0.901			
	T22	0.783	0.897			
	T23	0.701	0.904			
	T25	0.722	0.902			
	T26	0.697	0.904			
	T27	0.712	0.903			
	T28	0.733	0.902			

finally, online questionnaires are sent to students of the Distance Education College "marketing". The data collection issued a total of 500 questionnaires, 420 questionnaires were recycled, and 363 were valid.

We improved the questionnaire by the use of exploratory factor analysis. Before the exploratory factor analysis, we conduct KMO and Bartlett test, the results $\text{KMO} = 0.948 > 0.5$, $\text{Chi-Square} = 7205.749$ and $\text{sig} = 0$ reveal the data is suitable for factor analysis.

Though the principal component analysis method retained the items that its load on a factor is greater than 0.5, and its load on other factors are less than 0.5. According to this standard, we deleted T11, T14, T19, T20, T24.

Then, we conducted a reliability test, deleted items T7, T8 that reduce Cronbach's Alpha (Table 102.5).

Table 102.6 Scale and final items of lbs user experience measurement

Dimension	Serial number	Original numbers	Items
Useful	USE1	T1	The LBS application improves my efficiency of work
	USE2	T2	The LBS application is useful
	USE3	T3	The LBS application saves my time
	USE4	T4	The LBS application makes it easier to complete my task
	USE5	T5	The LBS application makes me better control the activities of life
	USE6	T6	The LBS application provides me enough information
Ease of use	EOU1	T9	The LBS application is ease to use
	EOU2	T10	Operate the LBS application is simple
	EOU3	T12	The way the LBS application provide information is transparent
	EOU4	T13	I learn how to use the LBS application very fast
Efficiency	EFF2	T16	The LBS application downloads and installs very quickly
	EFF4	T18	The LBS application updates and upgrades timely and effective
Creditable	CRE1	T17	The LBS application generated little error
	CRE2	T21	Use the LBS application software, my personal information will not be leaked to others
	CRE3	T22	The LBS application protect my important information
	CRE4	T23	I have confidence about the LBS application's ability to protect my personal information.
	CRE5	T25	The LBS application won't suddenly collapse
	CRE6	T26	The LBS application switch from one task to another very easy
	CRE7	T27	The LBS application can precisely execute what I want it to do
	CRE8	T28	Use the LBS application software, it's easy to revoke wrong operation
Satisfaction	SAT1	T29	I am satisfied with the LBS application
	SAT2	T30	I will introduce the LBS application to my friends
	SAT3	T31	It is very interesting to use the LBS application
	SAT4	T32	The LBS application work in the way I hope
	SAT5	T33	I need to have the LBS application
	SAT6	T34	Use the LBS application make me happy
	SAT7	T35	Use the LBS application makes me feel very proud
	SAT8	T36	I think people who never heard of the LBS application is outdated
	SAT9	T37	It make me more closely linked with others through using the LBS application
	SAT10	T38	The expense of using the LBS application is reasonable
	SAT11	T39	The LBS application meets my expectations

102.4 Result

Based on the above statistical analysis results, we deleted the items T7 and T8 which CITC are obvious lower than other items in the same dimension. After deleted these two items, the α value is increased, and the internal consistency is enhanced. Finally we get the following scale: (Table 102.6).

102.5 Conclusion

Under the background of the rapid development of domestic LBS applications industry, this article utilized empirical research to develop a scale to measure the user experience of location-based service applications.

First, we combed the conception and the development status of LBS applications. Then we reviewed the previous studies about user experience measurement, summarized a few elements that influence user experience. According to the literature review, focus group interviews and expert advice, we classified seven initial dimensions. Finally, we purified the scale with 363 valid questionnaires, we got 39 items under five dimensions, useful, ease of use, efficiency, creditable, satisfaction, to measure the user experience of LBS applications.

Understanding how to measure the experience from a user perspective, and then to improve the shortage to enhance the user experience provide a useful reference for LBS applications' developers and operators.

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Chapter 103
In Virtual Community: Fostering the Members Participation

Juan Luo

Abstract Now, the number of virtual communities in the world is increasing at an unprecedented rate. It has brought a whole new way of the life to people, the new forms of social organization also impact increasingly on everyone in the traditional communities. The rise of social media affords the companies to a richer relationship with the users through the virtual community. At present in domestic, scholars researched virtual community mainly in the concept, network interaction, and knowledge sharing of the virtual community. The literatures of users' participation in virtual community are relatively few. Understanding the users' needs in communities is the key to foster and maintain them participation in virtual communities. This paper explores the three stages of fostering participation of members and motivating cooperation in virtual community for virtual community initiator, and we hope to suggest some ideas and methods of for initiators.

Keywords Cooperation · Innovation community · Motivation · Sharing · Virtual community

103.1 The Meaning of Virtual Community

The concept of virtual community was first proposed by Rheingold (1993) and Lili et al. (2009). About the virtual community, it has been defined by different researchers from different angles. Rheingold (1994) defined virtual communities as the form of culture collection build by a group of people who communicating and exchanging ideas by computer bulletin boards and network; Plant proposed that, virtual community was various kinds of group or organizations formed by either

J. Luo (✉)
Department of Economy and Management, University of Electronic Science and Technology of China, Chengdu, China
e-mail: rrmmcjjluojuan@126.com

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temporarily or permanently communicating with each other through the electronic media in a common problem or a area of interest; HagelÓ and Armstrong (1997) pointed out that, it's a group gathered together by people on the network with common interests and needs, and it's a consortium formed by individuals or organizations with common values and interests in a shared semantic space through the exchange of electronic media, Preece (2001) define a virtual community is a virtual social space in order to obtain and provide information or support, in order to learn or find companionship together; in addition, some scholars (Balasubramanian and Mahajan 2001) believe that the virtual community is a cyberspace with participant communication and interaction as the core and supported by technical.

According to the definition of virtual community given by K. Joon, the virtual community is a predominant cyberspace for a group of people to interact their own common interests, to build relationship, to help their transactions and fantasies. At the same time, the virtual community face many challenges, from a social point of view, the challenges are in communication, motivation, leadership; from a technical perspective, the challenges are in the technical aspects. So, how to foster and maintain effective participation in the virtual community, is worthy of our consideration (Xiaolong and Fanghua 2007).

103.2 Virtual Community for Individuals

Get individuals to participate in the innovation community is the biggest obstacle to a successful innovative community. We support the premise in the study of Porter et al. (2011), that although communities can emerge organically, but, participation is often amplified because of specific and appropriate resources actively provided by firms to help members creating value for themselves and the communities. Algesheimer (2005) shown that When consumers have a strong worship of the company or brand, they will eager to participate directly into the members of the community and which initiated by the company.

To foster and maintain the continuing participation in virtual community, the initiator should have a depth understanding of members' needs. The virtual community can meet different needs of members, see in Table 103.1.

103.3 The Framework for Member Participation in Virtual Community

In order to understand the consumer needs fulfillment, and their motivations for participation, from the research literature by Mac Elory, we summed up the three stages of the company to successfully develop and maintain members to participate in virtual communities (see Fig. 103.1). The three stages are mutually, and the first stage is the basis of the latter two stages.

Table 103.1 Different needs that members fulfill in the virtual community

Customers' needs in virtual community	Description
Discover information	In virtual community, people may find value that provides access to information which can help them learning, solving problems, or making decisions
Build relationship with others	In virtual community, people are seeking to build fruitful relationships by interacting with others
Social identity/self-expression	In virtual community, people are eager to achieve self-awareness of being members in the group and they will fell gratified on the emotional connection or cognitive connection with the community, as well as the ability to express their connection in the community
To help others	In virtual community, people are happy to help other members in the group, especially the people with whom they have already developed a personal connection in the community
Entertainment	In virtual community, people are gratified of achieving the state of flowing while interacting with other members by the means of controlling over their experience with a community
The belongingness	In virtual community, people desire to the sense of attaching to the community, and they will fell gratified if they would having contributions to community that respected by others
The status/influence	In virtual community, members are seeking status and influence among the other people within the community

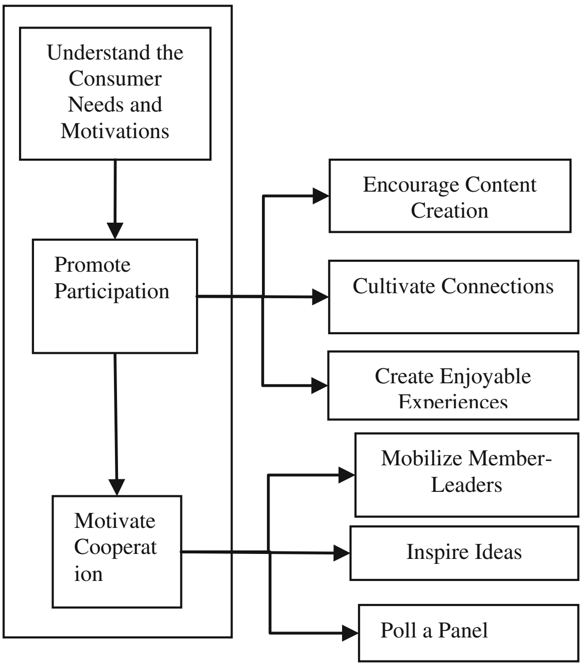

Fig. 1 Three stages to develop and maintain members to participate in virtual communities

103.3.1 Stage One: Understand the Consumer Needs and Motivations

Engagement is a phenomenon that situated in consumption, and it can obtain the best understanding and implement through the fulfillment of consumers' needs and their participation motivation. The fulfillment of customer's social and psychological needs, motivates them to participate in a variety of social media platform, that including the virtual community.

In virtual community, the emerging of the social capital brings the members a convenient to fulfill their hopes of helping others, especially in the forms of sharing information with other members. Based on the notion that the nature of participation motivation of customer engagement, and when the community initiator help them fulfilling their needs in community, they will create value, forming this framework. However, different members of the community will attempt to realize the different needs at different times. On this case, the participation driven by the value, as the basis for consumer participation, characterized the qualities, experience, scenarios, and full if meaning, and rely on the needs of individuals (Vargo and Lusch 2008). Therefore, when setting the goals, the managers should be appropriate to accelerate and enlarge their participation in the corporate community, according to the members' different needs in the community.

Among the SNS website, the "Douban" is the network of strangers at its inception. The sponsors of "Douban" understand that different people desire to understand more detailed information about the book, the audio and video products etc. before them buying these products, or sharing experience with others after they using these products. So, provide such a platform is a feasible way to attract members participating, and the members find like-minded members in the community then to build relationship with them. In the "Douban" community, almost any vice-works can be found in the record was read or the evaluating information and recommended information, that meet the members of the community to obtain the information they want to know about but different to get form the physical store.

All the contents of "Douban" are created by users themselves. The site contains three plates: the taste system (reading, movies, music), the expression system (I read, I see, I hear), and the communication system (the city, groups, and neighbors). The three plates were respectively used for the guidelines of the path in the subscriber station of recording sharing, found the recommended and members exchanging. The users with the same interests or have the same needs can communicate with other users in the corresponding system or subsystem, and obtain the desired information. Such as, in the subsystem of "group" of the communication system, a group called "cosmetic", any question about maintenance of the skin you can put forward or provide your own answers to other members, and can get the information they want or help to solve the problem of other members. When the posting has been response or recognized by other members of the same group, he or she will be gratified, and forming a sense of belonging. In the

"Douban Reading" section, the members will have evaluation or reviews on what they have read, the comments of people with a certain influence will be concerned by more members, and he or she will have more fans.

103.3.2 Stage Two: Promote Participation in Virtual Community

Although the fulfillment of inherent demand have motivated members to participate I the virtual community, then what the external factors for participation motivation? This is a very important issue, if the extra motivation can help the community to maintain the vitality, then the reluctant contribution of members mainly leads to the unsuccessful virtual community. Therefore, the second stage focus on exploring the initiator's role as the extrinsic motivation to promote consumers to participate in the virtual community. Porter et al. (2011) shows that three ways would be effective: encouraging the customer for content creation; culturing contact in the members of internal; creating entertainment experience.

103.3.2.1 Encourage Members to Contribute High-Quality Contents

In the community, rather than assume that these contributions will emerge organically, to encourage the members to make contributions for content proactively is the necessary conditions to help the virtual members participating actively. How to the sponsors to overcome these challenges? The managers of the community must determine the extent of the valuable information that shared with the members, to fulfill the members' internal needs and motivate them to participate in the virtual community. With full confidence in the customers to provide valuable knowledge and enjoyed in helping other members, similarly to build a reputation from their vast knowledge and other aspects, and to motivate members to participate in through creating high-quality content. In this case, the managers can help members to achieve the internal needs (such as the needs to help other members, or the needs for status/influence).

In the stage two, the sponsors focus on encouraging virtual community members to actively contribute information timely, accurately, and relevantly to the community. In the virtual community, managers should locating each of the section appropriately, put the core content of the communities or the content want to be seen most by the users in the place most easily to locate, and the content allows users to resonate, or the users will be interested in. Such as the well-known parent–child site "baby tree" site, in accordance with the plate in the home page, the managers issued the relevant knowledge of a wide range of baby education, health, learning and reflected different content posting by the users themselves in each forum, give convenient to users to navigate to the relevant interface accurately to access to the relevant information or get help by communicating with the specific members or helping solve the problem.

103.3.2.2 Fostering Contact Among Community Members

Members' interaction is the core of a virtual community, and it is often used to help members to meet needs of the learning/solving problems. It promoted the interactive learning among its members in virtual communities and the interpersonal relationships, which is called peer-to-peer problem-solving community (Mathwick et al. 2008). In such communities, the functions of Social capital is often as the glue to connect members of the society as a whole, and motivate members to help others, even the strangers voluntarily. What makes community members are willing to help others only with such a weak relationship with them?

The common identity theory argues that even the personal relationships in the circumstances of individual members, people can feel a sense of dependence on the society as a whole, and also feel the sense of common purpose with other members in the community (Baumeister and Sommer 1997). In this case, as a whole sense of responsibility of the society, the members often help others. In the virtual community, when a member's problem has been solved, he or she may never contact the problem-solving people or receive any help again from this particular member; although the relationship between people always lack of depth, the motivations of many members is helping others solving problem, because of their common identity with the society as a whole.

Fostering the connection between the members of peer-to-peer problem-solving community, not only arise the general sense of shared identity of community members, but also create the opportunity to cause the bonding between the individual members. Therefore, the sponsors can help members expressing their identity through creating content and promote the establishment of personal relationship, and then to motivate them participate in the community. Nowadays, more and more people using the social network to create and share their profiles, it provides an important opportunity to use the similar analysis to enrich the bonding between individuals and the virtual communities.

Such as, either "Douban" or "Mo gujie" site, are all well-known social networking sites. Because of the common interests or the wish to share experience with more people, they gathered in the same virtual community. The members can obtain the most professional, most personality, and most realistic evaluation and recommendation about the books, movies, clothes, and other things, and the members can also solve the doubt in a particular area they are familiar with for others, or share funny and interesting things of their common interests. Between the like-minded members, they have more interactions, and establish the friendship. In addition to the online community, the establishment of relationship also emerged offline, at the same time, it's good for increasing the sense of mutual trust between the members. Moreover, there are different groups in the "Douban" and "Mo gujie" site, the members inside focus on specific interests, the influence, the popularity, the needs for sale goods, or the wish to seek friendship, motivated by the interest in learning and sharing relevant experience with specific theme, they formed a promise, at the same time, they make contributions to the whole community (Ren et al. 2007). Small groups, promoting the bonding relationship between the members, in turn, it motivate members to contribute content in the community.

103.3.2.3 Create Entertainment Experience for Members

When people experience flow—a psychological state, that including experiencing happy, the feeling of absorbed, felling gratified, and controlling the experience of others, they provide their own experience toward a favorable attitude to the community sponsored by the company, especially when the experience of members is related to their interests, it's more accurate (Hagel 1999). In the virtual community, the pleasant, and the experience of mobility are seen as able to meet the needs of utilitarian (e.g., learner) and Hedonist (e.g., interesting people, adventure). The sponsors can provide a enjoyable experience flow-based, and allowing members to customize their experience within the community.

103.3.3 Stage Three: Motivate Cooperation in Community

In virtual community, the third stage of participation process focus on the role of sponsors in motivating cooperation of the community members. It will not only fulfill specific needs (status/influence) of members in community, but also affect both members and the community initiators to create value together. According to the framework, the first and second stage demonstrated the internal and external factors respectively motivate members to participate in community by fulfilling the needs of their own members in virtual community. In the third stage, the sponsors motivate consumers from the outside and to meet their needs, while intertwined their needs and desire to create value for members and for the sponsor own.

Porter et al. (2011) etc. suggested that, when members believe that the initiator has absorbed them through the community and empowered them, members are motivated to cooperation with the originator companies.

In the group context, the embedded members feel a high sense of dependence in the community and feel very suitable for this community, they would feel negative emotions, if they will leave the community. Scholars study shows that in the virtual community, the initiator is usually attempted by giving members information and the privilege that non-members can not enjoy to make them embedded in the community, which in turn enable members to achieve the participation behavior. Such as, the willing of participating in co-operation of new products or maintain loyalty to the company. These efforts can not only help members meet the needs in their status, but also help them increase their risk emotional perception in defection. They feel obliged to take positive measures to maintain the community's cultural and manage the community activities to help the community survive.

In the family Website "baby tree", members often share the story of the community, their own parenting experience, and experience in the community to a variety of information about educational baby, parenting baby, and provide the information on the activities that baby participation in the community to the newcomers for the community, in order to make them understand the culture of the community, because the newcomers usually hard to feel the hidden information embedded into the community. Therefore, to attract members to provide support and advice in the community, not only need to consider the products and services, but also taking into account the community's cultural, environment, and practices. In the community, the members are usually full of compassion to others in the same community or the same group, but the behavior to people outside of the community or group are very wise, these combined with creating conditions, are ready for the success of the community based on innovation. Participate in such tasks, both helped the members in community and the community sponsors. The members in the community fulfill their needs as a sense of belonging, status and influence, and the initiator make a vital link with external environment, and to support members' decision-making, problem-solving, co-production, or improving innovative capacity through the community (Mathwick and Rigdon 2004).

Even though the initiator successfully fostered a sense of embedded with members in the community, but if you want to motivate continued participation of members, it must convert into empowered members. Embedded members felt their sense of obligation to support virtual community initiator and contribute value to their own, but the empowered members more convinced that their supports would be an actual impact to the initiator. The Empowering is equivalent to the enaction of a person's responsibility to help community initiator creating results, and the same time, to strengthen the significance of community members. Furthermore, the reason why empowered members are gratified is not only owning the opportunity to have an impact on the community, meanwhile, their strong sense of freedom and access to the resources that provided by initiator, also enable effect them to influence the community.

The community initiator can create the necessary conditions and help the community members by giving them a certain ability to get a sense of empowerment. With democratic manner, consumers are often gathered in the virtual environment with amount of information, they sharing ideas, viewpoints, and the cooperative behavior will not hindered by policies, which can stimulate enthusiasm of members and create value with the initiator of the company freely.

Scholars' studies have shown that through the efforts of initiators, there are three ways are effective in motivating cooperation of empowered and embedded members in community: mobilize members of the leadership; inspire inspiration of members; the members vote for the strategic vision.

103.3.3.1 Mobilize Members of the Leadership

The Jones Soda's successful business strategy's core is giving member the status and opportunity to influence the company's policies and practices.

In the Web2.0 community, most of the content is created by members themselves, the opinion leaders always played an important role in the community. The members and content that receive more concerned from other members will have a more important position in the community or group, which can bring his followers to actively participate in the interaction, while also stimulating the identity of members to maintain their status and continue to create more new contributions. In the family Website "baby tree", there are many labels that are used to show the identity of members, such as the "Diary list", "the hot topic", "Diary adults", and "photos hero" etc., that inspired more members who want to be the leaders to create more contributions for the community, and also increases the activity of the community.

103.3.3.2 Inspire Inspiration of Members

Empowering is not only the efforts toward to consumers. The real empower is reflected by the consumers after them have the feeling of being empowered, it's a psychological feeling of organization's effort toward its members (Wang et al. 2007). When such results occur, that's good for retaining the valuable members. In the "Alpha City" of "Douban" site, there are many streets and the street layout as the reality, and each individual member has their own self-management area. The members can open their own shop, buy apartment buildings, show their own characteristics or publicize and sell their products. The community grant members the autonomous power, which give the valued member in the community the opportunity to show their own characteristics in "Alpha City", they are welcomed by other members, and also meet their own needs.

Creating the participation by empowering, the community Initiator must recognize the members' contributions and ensure the voice of members be heard and be appreciated is the key point (Daft and Weick 1984). When the appropriate relationship isn't reflected in embedding and empowering, members began to feel neglected, and lost its importance in the community. At this time, members will engage in negative word of mouth toward the company that they are loyal strongly before. Therefore, given the high contributor to a dedicated position, and for any members of their contributions, regardless of whether his or her thoughts, as well as the extent to which managers implement, the managers should encourage the sharing and participation.

103.3.3.3 Members Vote for the Strategic Vision

Virtual research communities, has become more and more popular and successful, mainly because the initiator of these communities providing unique opportunities for participation in the important research that in their guidance, to embed and empower members of the community. These Particularly important members usually extend to the most loyal customers of the sponsors. By communicating, to understand how they use the feedback of the members to improve the company's achievement and added value for consumers who give the feedback to sponsors, meanwhile, the sponsors have promote trust and empowering.

103.4 Conclusion

This article has discussed the three stages of fostering and maintaining participation of members in virtual communities, namely understanding the motivation of consumer participation; promoting participation; and inspiring cooperation. In the first and the second stage, mainly from the internal and external factors to fulfill the members' needs in order to foster and motivate them to participate in the virtual community; in the third stage, the sponsors focus on motivating consumers by meeting their needs from the outside, from the extrinsic factors to motivate cooperation in the community. By embedding and empowering to cultivate the trust and loyalty of the members of the community. The managers must understand and meet the different needs that members desired in the virtual community, and we summarized the needs of members can be fulfilled in the community, that including information, relationship building, social identity/self-expression, helping others, entertainment, a sense of belonging, status/influence. I hope that the research of this article can provide some guidance for the community sponsors on fostering and maintaining Continuous participation in the virtual community.

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Chapter 104
Model Research of Multi-Objective and Resource-Constrained Project Scheduling Problem

Rong Zhou, Chun-ming Ye and Hui-min Ma

Abstract Keeping the time, cost, quality and resources in balance is the key factor to building the general objective in the engineering project scheduling, which is related to the success or failure of the whole project. The paper first establishes time, expenses, resources and quality objective functions, and then builds comprehensive optimization model by dimensionless and dynamic weighting methods. At last, the paper applies the model into real project case and uses chaos particle swarm optimization to solve the problem. Through the real application example, the article proves that this comprehensive optimization model combining with chaos particle swarm optimization algorithm can solve the multi-objective optimization problems more accurately and rapidly, which gain the ideal effect on construction period cut, cost reduction, quality improvement and resources balance.

Keywords Chaos particle swarm optimization · Dimensionless · Dynamic weighting methods · Multi-objective · Project scheduling

104.1 Introduction

Keeping the time, cost, quality and resources in balance is the key factor to building the general objective in the engineering project scheduling. In order to gain an all-round and all-process planning, organization, controlling and

R. Zhou (✉) · C. Ye
School of Management, University of Shanghai for Science and Technology, Shanghai, China
e-mail: zhourong198802@sina.com

H. Ma
Shanghai electrical college, Shanghai, China

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coordination, it is necessary to set up a scientific multi-objective comprehensive project-scheduling model.

Particle swarm optimization (PSO) is a kind of evolutionary computing technology based on intelligent optimization algorithm which aroused widespread concern as soon as it was put forward (Kennedy and Eberhart 1995). But basic PSO is easy to result in 'premature' phenomenon, so scholars put forward many kinds of different improvement methods.

For example, literature Jun-min and Yue-ling (2008) presents the CPSO by combining chaos with particle swarm optimization; literature Hong et al. (2005) uses PSO based on priority arrangement coding method to solve resource-constrained project scheduling problem (RCPSP).

This paper mainly research in multi-objective and resource-constrained project scheduling problem. It first establishes time, expenses, resources and quality objective functions, and then builds comprehensive optimization model by dimensionless and dynamic weighting methods. At last, the paper uses CPSO to solve the mode problem and gain the balance among the targets of time, cost, quality and resources.

104.2 Model Establishment

104.2.1 Concept Definition

First of all, according to the actual condition, the paper gives following definition and assumptions of time, cost, quality and resources in the project-scheduling problem (Wei-bo and Quan-yuan 2011).

Definition 1: reasonable time means during which period the project investors can gain the economic benefits in normal conditions of engineering project.
Definition 2: total cost includes direct cost and indirect cost.
Definition 3: total quality is got by weighting of each task.
Definition 4: resource-balance is the bias squares of the resource consumption of each period and the average resource consumption of the whole process.

The specific problem can be described as below: a project contains J tasks and there are ordering relationships between them. The article sets that task 'j' can't start before its pre-tasks 'i' end ('i'$\in P_j$, P_j is the pre-tasks set of task 'j'). Task 1 is the only first beginning task and task J is the only last ending task which are called virtual task and do not cost resource and time. The execution time of the task 'j' is 'd_j'. According to the shortest execution time of the tasks, we can get the earliest and the latest finishing time of each tasks [EF_j, LF_j].

104.2.2 Project Time-Model

The time-model of project scheduling problem can be established as below:

$$\sum_{t_f=EF_J}^{LF_J} t_f \tag{104.1}$$

$$\text{s.t.}\begin{cases}\sum\limits_{t_f=EF_i}^{LF_i} t_f \le \sum\limits_{t_f=EFj}^{LFj} t_f - d_j & \mathrm{i} \in \mathrm{P_j} \\ \sum\limits_{j=1}^{J} \sum\limits_{q=\max\{t_f, EF_j\}}^{\min\{t_f+d_j-1, LF_j\}} r_{jk}^{\rho} \le R_k^{\rho} & k = 1, 2 \cdots K \\ \sum\limits_{j=1}^{J} \sum\limits_{t_f=EF_j}^{LF_j} r_{jn}^{v} \le R_n^{v} & n = 1, 2 \cdots N \\ j = 1, 2 \cdots J & t_f = EF_j \cdots LF_j \end{cases} \tag{104.2 – 104.5}$$

$F_T = \sum\limits_{t_f=EF_J}^{LF_J} t_f$ is the time objective function. Formula (104.1) means the minimum ending time of the final task. Formula (104.2) is the constraints of ordering relationship. Formula (104.3) and (104.4) is the constraints of resource consumption, and r_{jk}^{ρ} is the quantity demanded of renewable resource k in task j. Formula (104.5) gives the scope of variables.

104.2.3 Project Cost-Model

The paper defines that total cost includes direct cost and indirect cost.

Direct cost mainly considers direct engineering fee and project maintenance fee, which is related to the resource usage and the project time, and its formula is $\mathrm{C_d} = \mathrm{C_r} + \mathrm{C_m}$.

$\mathrm{C_r} = \sum\limits_{k=1}^{K} \left(C_k^{\rho} \cdot R_k^{\rho \max}\right) + \sum\limits_{n=1}^{N} \left(C_n^{v} \cdot R_n^{vu}\right)$ is the total cost of the resource consumption.

C_k^{ρ} is the unit cost of renewable resource k. C_n^{v} is the unit cost of non-renewable resource n.

$R_k^{\rho \max} = \max\limits_{t=1\cdots D} \left(\sum\limits_{j=1}^{J} \sum\limits_{q=\max\{\mathrm{t_f}, \mathrm{EF_j}\}}^{\min\{\mathrm{t_f}+\mathrm{d_j}-1, \mathrm{LF_j}\}} r_{jk}^{\rho} \right)$ is the maximum consumption level of the renewable resource in the whole project process.

$R_n^{vu} = \sum\limits_{j=1}^{J} \sum\limits_{t_f=EF_j}^{LF_j} r_{jn}^{v}$ is the consumption level of the non-renewable resource in the whole project process.

$C_m = \gamma \cdot \sum_{t_f=EF_J}^{LF_J} t_f$ is maintenance fee and γ. is the unit maintenance cost.

There is also an amount of daily operation management and period-award cost in the actual project, which can't be ignored. This is called indirect cost.

So the improved project total cost model is:

$$\min \sum_{k=1}^{K} \left(C_k^{\rho} \cdot R_k^{\rho\max}\right) + \sum_{n=1}^{N} \left(C_n^{v} \cdot R_n^{vu}\right) + \gamma \cdot \sum_{t_f=EF_J}^{LF_J} t_f + \partial(T_J - D) + C_J \tag{104.6}$$

$$s.t. \begin{cases} (104.2{-}104.5) \\ ST_J \le D \end{cases} \tag{104.7}$$

∂ is the period-award cost coefficient. T_J is the project actual finishing time. D is the project planning finishing time; C_J is the operation management cost of the whole project.

$F_c = \sum_{k=1}^{K} \left(C_k^{\rho} \cdot R_k^{\rho\max}\right) + \sum_{n=1}^{N} \left(C_n^{v} \cdot R_n^{vu}\right) + \gamma \cdot \sum_{t_f=EF_J}^{LF_J} t_f + \partial(T_J - D) + C_J$ is the cost objective function. Formula (104.6) means the minimum cost of the whole project. Formula (104.7) is the constraints of project time.

104.2.4 Resource-Balance Model

Resource-balance means making the resource usage of the project in balance (Dong-hai and Xiang-qun 2001). As a necessary consideration, we should try to reach the minimum bias squares of the resource consumption of each period and the average resource consumption of the whole process.

$$\min \left[\sum_{k=1}^{K} w_k \sum_{t=1}^{T_J} \left(R_{kt}^{\rho} - \overline{R}_k^{\rho}\right)^2 + \sum_{n=1}^{N} w_n \sum_{t=1}^{T_J} \left(R_{nt}^{v} - \overline{R}_n^{v}\right)^2\right] \tag{104.8}$$

s.t. (104.2−104.5)

$$F_R = \left[\sum_{k=1}^{K} w_k \sum_{t=1}^{T_J} \left(R_{kt}^{\rho} - \overline{R}_k^{\rho}\right)^2 + \sum_{n=1}^{N} w_n \sum_{t=1}^{T_J} \left(R_{nt}^{v} - \overline{R}_n^{v}\right)^2\right]$$

is the resource-balance objective function. Formula (104.8). w_k, w_n is the weight of resources k and n. R_{kt}^{ρ} is the consumption of the renewable resource during the t period time and $\overline{R}_k^{\rho}$ is the average consumption level of the non-renewable resource in the whole project process. So as R_{nt}^{v} and $\overline{R}_n^{v}$.

104.2.5 Project Quality-Model

Considering of the particularity of the project quality and refer to the literatures (Jian et al. 2004; Yao-hong et al. 2006; Kaheled and Amr 2005; Afshar et al. 2007), the usual weighting grade method has strong subjectivity and is difficult to get the score in the actual operation process. So the paper further research project quality calculation method and gain the following formula according to the previous statistical data of project time–cost-quality and use the software of Eviews5.0 or matlab7.0: $Q = 38.6711T^{0.1044}C^{0.1046}$ (Qiang 2007).

At last, we get the project quality model as below:

$$\max \sum_{j=1}^{J} Q_j \tag{104.9}$$

s.t. (104.2–104.5) $F_Q = \sum_{j=1}^{J} Q_j$ is the quality objective function.

$Q_j = 38.6711 \times T_j^{0.1044} \times C_j^{0.1046}$, T_j is the executive time of task j and C_j is the cost of task j.

104.2.6 The Establishment of Multi-Objective Model

In order to realize Comprehensive optimization of the project, here we should weight and sum the time–cost-resource-quality objective.

$$\min\{F = W_T F_T + W_C F_C + W_R F_R - W_Q F_Q\} \tag{104.10}$$

W_T, W_C, W_R, W_Q is the weighting of these objectives, and $W_T + W_C + W_R + W_Q = 1$.

Because every objective has its own Units and dimension, in order to combine all the targets into a general objective, the paper uses dimensionless method to deal with these targets in advance through the following formula:

$$F_T^* = (F_T - F_{T\min})/(F_{T\max} - F_{T\min}) \tag{104.11}$$

$$F_C^* = (F_C - F_{C\min})/(F_{C\max} - F_{C\min}) \tag{104.12}$$

$$F_R^* = (F_R - F_{R\min})/(F_{R\max} - F_{R\min}) \tag{104.13}$$

$$F_Q^* = (F_{Q\max} - F_Q)/(F_{Q\max} - F_{Q\min}) \tag{104.14}$$

F_T^*, F_C^*, F_R^*, F_Q^* is the result of each objective by dimensionless method. $F_{T\max}$, $F_{T\min}$ is the maximum and minimum results of the function F_T, so as $F_{C\max}$, $F_{C\min}$; $F_{R\max}$, $F_{R\min}$ and $F_{Q\max}$, $F_{Q\min}$.

And we should weight and sum the above objectives as well. Here the paper uses a kind of dynamic weighting methods, which can gain the weight according to the result of the objective function in each iteration.

$$W_i = \frac{\left|F_i(X) - \overline{F_i}\right|}{\sum_{i=1}^{n} \left|F_i(X) - \overline{F_i}\right|} \tag{104.15}$$

$\overline{F_i}$ is the objective expectation, which can directly get by experience if possible.

As last, the multi-objective project scheduling comprehensive optimization can be established as below:

$$\min\left\{F = W_T F_T^* + W_C F_C^* + W_R F_R^* + W_Q F_Q^*\right\} \tag{104.16}$$

104.3 Chaos Particle Swarm Optimization

104.3.1 PSO

The particle swarm optimization is a kind of new global optimization evolutionary algorithm invented by Kennedy and Eberhart (1995). The updated formula of particles speed and position :

$$\mathrm{V} = \mathrm{w}^*\mathrm{V} + \mathrm{c1}^*\mathrm{rand}()^*(\mathrm{pBest} - \mathrm{Present}) + \mathrm{c2}^*\mathrm{rand}()^*(\mathrm{gBest} - \mathrm{Present}) \tag{104.17}$$

$$\mathrm{Present} = \mathrm{Present} + \mathrm{V} \tag{104.18}$$

V is particle speed, Present is particle present position. rand() is an random number between 0 to 1, c1 and c2 is learning factor. As usual, c1 = c2 = 2, w is the weighting number between 0.1 and 0.9.

Particles finally fly to the optimal location in the solution space through the above formula and put out the global best answer—gBest.

104.3.2 CPSO

The basic thought of chaos optimization is: first, it produces a group of chaotic variables and then introduces them into optimization variables by the method like carrier to make it present chaotic state, and let the chaotic variables have the same value range with optimization variables, next use the chaotic variables to search the answer (Bing and Wei-sun 1997).

The typical chaos system logistic formula is:

$$x_{k+1} = \mu x_k(1 - x_k),\ 0 \le x_0 \le 1 \qquad (104.19)$$

μ is controlling parameter, x_k ($k = 0, 1, 2, \ldots$) is variables.

The detailed process of CPSO is listed as below:

Step 1 Chaos initialization. Generate a group of particles randomly and chaos-initialize the particles' speed and position. Calculate the particle fitness and record the initial particle personal extreme and global extreme.

Step 2 Particle swarm update. Use formula (104.17) and (104.18) to update particle speed and position and calculate the particle fitness (F_1) by the fitness function.

Step 3 Chaos update. Take the particle position generated in step 2 as chaos variables and use formula (104.19) to update chaotic sequence and generate the new particle position of chaos. Calculate the chaos particle fitness (F_2).

Step 4 Fitness comparison. Compare F_1 and F_2 to keep the better one. Then update the particle pBest and get the gBest.

Step 5 Ending. Put out the gBest when reach the max iteration times, or return to step 2.

104.3.3 Algorithms Design

104.3.3.1 Particle Coding and Initialization

The dimension in particle searching space represent the project task J, x_{ij} in each dimension is an random number between 0 and 1, whose size means the priority order scheduling of task j. The paper set 1 for the virtual start task priority number and 0 for the virtual ending one. But it may be not accord with the logical relationship constraints. So we have to add a program of logical relationship judgment to adjust particle order.

104.3.3.2 Scheduling Generation

This paper uses Serial Scheduling Scheme (SSS) (Kolisch 1996), and its main thought is: do the tasks according to the arranged order and keep the start executive time of task j between its EF_j and LF_j. During the program designing, we choose the earliest start time which first satisfied with the resources constraints as the actual start executive time of the task represented by T_f.

104.3.3.3 Particle Update

The paper uses formula (104.17) and (104.18) to update the particle speed and position and Adopt the priority rule mentioned above to get x_i' and put it into serial scheduling scheme and obtain the fitness. If $v_{ij} > 1$, then $v_{ij} = 1$; if $v_{ij} < -1$, then $v_{ij} = -1$.

104.4 Application Example

The paper uses CPSO to solve the project-scheduling problem through adopting the actual case referring from the literature (Qiang 2007). Here we set the project units maintenance cost being 1, period-award cost coefficient being 1.5, operation management cost of the whole project being 9.4 and project planning finishing time being 24 day.

According to the task logical relationship in Table 104.1, we draw the project network diagram of Fig. 104.1 (Table 104.2).

The paper uses matlab7.0 software and adopts CPSO to solve the problem. The parameters are set as below:

Table 104.1 Operation information table

Task no.	Execution time	After task No.	Resources demand	
			Labor	Material
1	0	2, 3	0	0
2	2	4	4	15
3	3	5, 6, 7	8	30
4	2	9	8	35
5	4	12	10	40
6	2	8	5	20
7	3	12	3	30
8	3	12	5	12
9	5	10, 11	8	30
10	3	13, 14	4	20
11	4	14	8	32
12	3	15	12	45
13	2	16	2	10
14	3	16	4	40
15	5	17	8	80
16	2	18	2	10
17	3	19	14	82
18	3	19	6	30
19	2	20	10	85
20	2	21	10	30
21	0	–	0	0

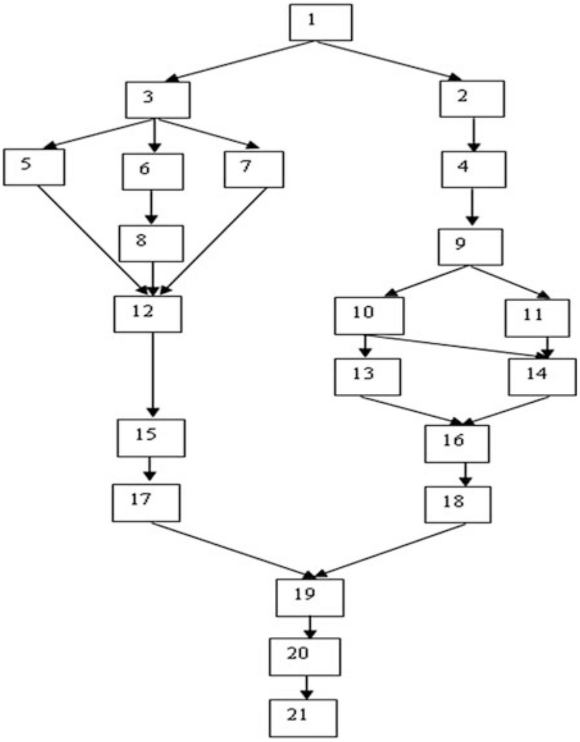

Fig. 104.1 Project network diagram

Table 104.2 Resources information table

	Labor	Material
Max consumption level	25	120
Units resource cost	0.5	0.1

Table 104.3 Comparison for the running result

Algorithm	Ave distance to the best solution (%)	Occupation of the best solution (%)
PSO	0.027	98.60
CPSO	0.012	99.80

$$w = w_{\max} - (w_{\max} - w_{\min})/D\max,\ w_{a\max} = 0.9,\ w_{\min} = 0.4,\ c_1 = c_2 = 2,\ D\max = 500,\ M = 50.$$

The running result is listed as Tables 104.3, 104.4, and 104.5.

Table 104.4 CPSO running rseult

	Time	Quality	Resource	Cost
CPSO	26	93.07	99700	1715000

Table 104.5 Task execution decision arrangement

No.	1	2	3	4	5	6	7	8	9	10	11
Start time	0	0	0	2	3	6	3	8	4	9	9
No.	12	13	14	15	16	17	18	19	20	21	
Start time	11	12	13	14	16	19	18	22	24	26	

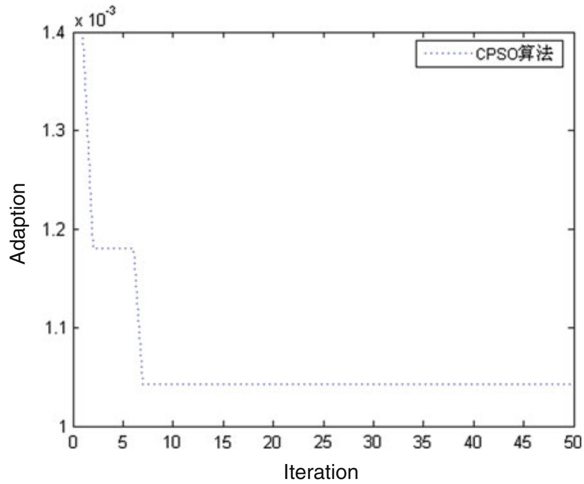

Fig. 104.2 Chart of CPSO running result

Figure 104.2 is the fitness chart of the CPSO running result. It can be seen that CPSO reach the convergence at the eighth iteration, so it has a strong convergence and stability.

104.5 Conclusion

Time, cost, resource and quality are important control targets in the project scheduling. The comprehensive model for the multi-objective project scheduling problem established in the paper is proved being scientific and effective. It is also the key factor to doing the optimization design and solving actual project case.

Actual project scheduling problem is complicated, so we should use mathematic model to make it more abstract and simplified. So the paper establishes time, expenses, resources and quality objective functions, and then builds comprehensive optimization model by dimensionless and dynamic weighting methods. Finally, it uses CPSO to solve the problem and proves that it can reach an ideal effect.

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Chapter 105
On Pareto Optimal Criterion for Long-Term Economic Growth

Jin-she He

Abstract Beveridge curve, Phillips Curve, Okun's Law are "Curve Criterions" to estimate whether the economy is running well. Thus, some of them are based on Long-term analysis and some on Short-term. The problem is that they are all "Statistical Criterions", relying on a certain country's or region's own economic practice, and they don't have that much instructional significance to others. Based on Pareto Optimality, this essay presents an optimal theoretical criterion for Long-term economic growth, which can be applied to the economic practice in any country or region.

Keywords Engel coefficient · Long-term economic growth · Pareto optimality · Proportion structure · Theoretical criterion

105.1 Introduction

The writer of this essay has once presented the criterion of quantification "Proportion structure" to estimate whether it is reasonable in income distribution or the distribution of resources (He 2010): at the micro economic level, there is the Pareto optimal criterion of family's "Proportion structure", which can guide consumption to meet its "Five Needs" (Maslow 1999) for "Happiness and Harmony" (Bruni 2006); and the Pareto optimal criterion of manufacturer's "Proportion structure", which can help the manufacturer to input "Four actors" to achieve people's "Happiness and Harmony". This essay will talk about the Pareto optimal criterion of macroeconomic "Proportion structure" for people's "Happiness and Harmony" in Long-term economic growth.

J. He (✉)
Department of Economy and Trade, Zhengzhou Institute of Aeronautical Industry Management, Zhengzhou, China
e-mail: hejs@zzia.edu.cn

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105.2 Hypothesis

105.2.1 Long-Term Production Function

Assume the output is Y, there are two production factors Labor (L) and Capital (K), so Cobb-Douglas production function is:

$$Y = AL^{\alpha}K^{\beta} \tag{105.1}$$

In the function, A reflects the endogenetic growth factor for technical progress, also called as total factor productivity. A represents the quality of the input factors (L and K), indicating that the technical progress can be reflected by the improvement of the efficiency in "all" input factors.

To show the contribution all factors do for the economic growth, Cobb-Douglas production function can be indicated in the form of growth rate. That is:

$$\frac{\Delta Y}{Y} = \frac{\Delta A}{A} + \alpha\frac{\Delta L}{L} + \beta\frac{\Delta K}{K} \tag{105.2}$$

It shows that output growth rate $\frac{\Delta Y}{Y}$ depends on the contribution rate of labor growth $\alpha \cdot \frac{\Delta L}{L}$, the contribution rate of capital growth $\beta \cdot \frac{\Delta K}{K}$, and the rate of technological advance $\frac{\Delta A}{A}$.

The marginal productivity of input factors in labor (or capital) represents that the increase in production is influenced by one unit increase in labor (or capital) under the circumstance of the constant capital (or labor). Respectively, they are:

$$\frac{\Delta Y_L}{\Delta L} = \alpha\frac{Y}{L}, \; \frac{\Delta Y_K}{\Delta K} = \beta\frac{Y}{K} \tag{105.3}$$

In which, α, β are input factors' output elasticity coefficient, respectively standing for the change rate in production value caused by the changes in the labor and the capital. That is:

$$\alpha = \frac{\frac{\Delta Y_L}{Y}}{\frac{\Delta L}{L}}, \; \beta = \frac{\frac{\Delta Y_K}{Y}}{\frac{\Delta K}{K}} \tag{105.4}$$

105.2.2 "Generalized" Marginal Analysis

By the mathematical language, "generalized marginality" means "derivative of the dependent variables about the independent variables". The derivative can be expressed not only as the differential ratio, but also as incremental ratio.

105.3 Theoretical Criterion

The Long-term Economic analysis aims at studying how to achieve the sustainable, full, and real economy growth for people's happiness. Therefore, the criterion of the long-term economic growth can be discussed individually as followings.

105.3.1 The Pareto Optimality Criterion for the Full and the Real Economic Growth

Assume the labor is L, the labor under the full employment is $\bar{L}$; the capital is K, the capital under the full employment is $\bar{K}$; the output is Y, the output under the full employment is $\bar{Y}$. So, to eliminate the unemployment, $\Delta \mathrm{L} = \mathrm{L} - \bar{L}$ is the increment of the labor and $\Delta \mathrm{K} = \mathrm{K} - \bar{K}$ is the increment of the capital, which mean the increments of the labor and the capital that the economy achieves the full employment. At this moment, the increment of the output is $\Delta \mathrm{Y} = \mathrm{Y} - \bar{Y}$.

The real economic growth is to eliminate the factor of the price changing. If $\mathrm{Y} > \bar{Y}$, that is to say, there is inflation in economy, so ΔY means there is no inflation; if $\mathrm{Y} < \bar{Y}$, which means deflation exists, so ΔY means there is no deflation (He 2011).

Hence, based on the theory of marginal analysis, under analysis about the long-term macro economy, the marginal condition or the Pareto optimal condition of full and real economic growth is

$$\frac{\Delta Y_L}{\Delta L} = \frac{\Delta Y_K}{\Delta K} \tag{105.5}$$

According to Eqs. (105.5) and (105.3) can be changed to:

$$\frac{\Delta Y_L}{\Delta L} = \alpha \frac{Y}{L} = \beta \frac{Y}{K} = \frac{\Delta Y_K}{\Delta K} \tag{105.6}$$

That is

$$\alpha \frac{Y}{L} = \beta \frac{Y}{K} \tag{105.7}$$

Or

$$\frac{K}{L} = \frac{\beta}{\alpha} \tag{105.8}$$

Because α and β are exogenous variables or constant, the ratio of the capital over the labor $\frac{K}{L}$ is a constant, which means that labor and capital are input with a fixed proportion of $\frac{\beta}{\alpha}$.

Hendrik Samuel Houthakker once discovered when every manufacturer input its production factors with a constant proportion, that is to say, when the production function of every manufacturer in the industry is a kind of Wassily Leontief's production function, the aggregate production function about the full and real economic growth has the form of Cobb-Douglas production function (Sato 1975). Nevertheless, Hendrik didn't find the optimal condition in it.

Actually, the constant proportion is called Lyon Cardiff coefficient which every manufacturer inputs factors with, and obeys Pareto distribution among manufacturers (Eatwell et al. 1987). Pareto optimality is the theoretical form of Pareto distribution (He 2011). Thus, in the Cobb-Douglas production function about full and real economic growth, α and β must theoretically accord with the Pareto optimal criterion, meaning, when $Y = AL^{\alpha}K^{\beta}$, the proportion structure of α over β is 86.6:13.4, or that of β over α is about 0.15. Here is some real evidence: Cobb and Douglas structured such a production function as $Q = AL^{\frac{3}{4}}K^{\frac{1}{4}}$ basing on the United States' economic data from 1899 to 1922 (Gao 1996). In the production function, the contribution ratio between the labor and capital to the output is $\frac{3}{4} : \frac{1}{4}$, or 75:25 %. However, this essay thinks that the optimal theoretical value of the contribution ratio should fit the Pareto optimal criterion of the "two equal parts", which is 86.6:13.4 %.

105.3.2 The Pareto Optimal Criterion for the Sustained Economic Growth

Concerning Pareto optimal criterion of the "proportion structure", there will be the character of "coordinating relation at the same level" between the objects while doing classification management about them. For example, inputting labor and capital for manufacturing, it is the technology that converts the labor and capital into outputs. Among them, there is the character of "coordinating relation at the same level" between labor and capital, while there isn't the character between labor, capital and technology. But, labor and capital together formed the input factor of "quantity", and the technology is the input factor of "quality", there being the character of "coordinating relation at the same level" between technology and capita capital.

In the long-term, the sustained economic growth depends on technology progress. Thus, the criterion for the sustained economic growth is that the contributions between technology progress and capita capital should fit the Pareto optimal ratio of the "two equal parts", that is, 86.6:13.4 %. Here is some real evidence: Solow found a conclusion that the contribution rate $\frac{\Delta A}{A}$ of technology progress for the real output is 87.5 % and that $\frac{\Delta y}{y}$ of capita capital is 12.5 %, which is based on the statistic data of United States during 1909 to 1949 (Huang 2005).

105.3.3 Pareto Optimal Theoretical Criterion for Engel Coefficient

To analyze the long-term economic growth better, should we follow not only the Pareto optimal criterion of the input-to-output contribution, but also that of the real growing effect.

Engel coefficient is the proportion of total food expenses over total personal consumption expenditure, meaning: the less one family earn, the bigger the proportion of the food expenses is in the family income; but with the more income the family get, the proportion of the food expenses in the family income will drop. By extension, the poorer one country is, the bigger the proportion of the food expenses in the capita average income is; but with richer the country is becoming, that proportion will decline as well.

The division standard for the resident income level and living standard in every country published by U.N. depends on the Engel coefficient is that, above 60 % means poor, 50–60 % means having enough to eat and wear, 40–50 % means fairly well-off, 30–40 % means rich, 20–30 % means richer, and under 20 % means extremely richer. But, this is just an “experiential” “statistic criterion”.

In fact, “Happiness and Harmony” is the final goal of people living (Smith 1999), and the satisfaction and the coordination of people’s “Whole need” (Skousen 2001). Engel coefficient cares about the people’s expenses on food, which means that it focuses on investigating the people’s satisfaction situation of “diet need” in the “whole need”; therefore, the people’s “whole need” can be divided into “diet need” and “other need”. This equals dividing “whole need” into “two equal parts”. The commodity for the people’s diet satisfaction is a lot but costs a little, while self-realization is the most sublime goal in life. Thus, “diet need” constructs the “minor majority” for people’s “happiness and harmony”. To combine with the analysis above, the Pareto optimal proportion is 13.4:86.6 % for the resident consumption expenditure to meet the “diet need” and “other need”. That is to say, Pareto optimal criterion of Engel coefficient for the resident living “happiness and harmony” is 13.4 %.

105.4 Conclusion

1. “Proportion structure” is symmetrical. Such as, from the perspective of the money amount, the Pareto optimal proportion is 13.4:86.6 % between “diet need” and “other need”; but from the perspective of the number of the commodity kind, it is symmetrically 86.6:13.4 %. From the perspective of both, it has the same situation as labor and capital’s contribution to output.
2. The theoretical criterion put forward by this essay for the long-term economic growth, contains not only the criterion for economic growth forecasting, such as, the optimal “proportion structure” between labor and capital, and between

input factors and technology progress; but also the criterion for economic growth evaluating, such as, Pareto optimal theoretical criterion of "Engel coefficient".

3. What this essay puts forward is an ideal or theoretical criterion for the long-term economic growth, but not the "experimental statistic criterion", not based on the economic practice of a certain country or region, so it has a general instructive significant to the economic growth of all countries or regions.
4. Based on the real data, by the Pareto optimal theoretical criterion, there is a way to find the deviation and the error in the real economic growth. And then, by establishing some solutions, the deviation and the error will be continually fixed to achieve the long-term economic growth.

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Chapter 106
Political Connection of State-Owned Enterprises: An Analysis Based on the Listed Companies of Shanghai and Shenzhen Stock Markets

Jing Liu

Abstract Political connection of state-owned enterprises (SOEs) is a relatively sensitive topic. From the perspective of the SOEs' tax burdens, the relationship between the tax burdens and the political connections of the SOEs at different administrative ranks is researched in this paper. The research shows that the effects of political rights and political cost co-exist in the political connections of the SOEs as the requirements of reinforcing the corporate social responsibility and inspiring the economic development and ensuring the financial income are imposed on the SOEs. The "effect of political rights" exists mainly for the political connections of the SOEs at provincial level or above, while the "effect of political cost" exists mainly for the political connections of the SOEs under provincial level.

Keywords Political connection · SOEs · Tax burden

106.1 Research Overview

The tax burden refers to the ratio between taxpayer's tax payable and its value of tax assessment basis, namely, the economic burden assumed by the taxpayer to fulfill its obligations to pay the taxes. A serious unequal situation of tax burdens is caused among the enterprises due to the complexity of current tax law systems in China, the flexible administration in the tax collection and management, as well as overdue system in China centered on "officialdom standard" enables the impact of political connections on the tax burdens of the enterprises to be more prominent, and such impact either requires the local governments to provide the overriding-tax concessions to the relevant enterprises for supporting the enterprise

J. Liu (✉)
Administration of Industry and Commerce Department, Changsha University, Changsha, Hunan, China
e-mail: cxstatus@ccsu.cn

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development to reduce their tax payables through various means, or requires weakening the supervision and providing a variety of non-tax concessions in disguised form to the enterprises so as to guarantee the dominant position of the enterprise in the competition and accordingly raise its profit level. In China's current situation, the existence of the SOE's political connections may either give rise to the "effect of political rights" to increase the business interests, or result in the "effect of political cost" to impair the business interests.

Jensen and Meckling believed in their studies that, the larger the firm size was, the stricter the government would be and the heavier for its tax burdens, and therefore the "effect of political cost" would be generated. Birnbaum and Murray (1983) however held that the firm size would result in the "effect of political rights" and result in that the enterprises with a larger scale would possess more political and economic resources to affect the tax planning of the enterprises and even the national tax legislation, enabling the taxation to move toward the direction in favor of increasing the business profit, so as to reduce the tax burden level of the enterprise.

Due to the factor of tax system, majority of foreign study all take the corporate income tax as the analytical basis for enterprise's political connections and the actual tax rate of corporate income tax as the main indicator of analyzing the enterprise's tax burdens. Zimmerman (1983) and Kern and Morris (1992) considered in their studies that there was a positive correlation between the actual tax rate and the firm size; the larger the firm size was, the more the tax income declared would be and the higher the assumed effective tax rate would be because the business administration would become more standardized. But some studies also have the attitude toward the negative correlation between the actual tax rate and the firm size. Holland (1998) and Derashid (2003) found that, the larger the firm size was, the more standardized the business administration would be, and the management cost and tax compliance cost expenditure would be reduced so as to reduce the actual tax rate of the enterprise. Gupta and Newberry (1997) found in their studies of the American corporations that the actual tax rate of the enterprises was related to the capital structure, capital intensity and earnings position, and there was not correlation with the firm size in a long run. Jensen (1986) however found, based on the data analysis of European enterprises, that the important factors affecting the actual tax rate of enterprises included the firm size, capital intensity, operating performance, financial leverage ratio, and the like.

Gao and Tian (2004) believed in their studies that the actual tax rate of the listed companies was closely related to the competition of local governments. Wang (2003) researched the factors affecting the actual tax rate of listed companies and found that the income tax rate was subject to a positive correlation with the firm size, and a negative correlation with the financial leverage ratio and the capital intensity, and was not correlated to the rate of return on assets. Wu et al. (2008) researched the relationship between the tax preference and the government background of the executives of listed companies and found that the applicable tax rate and the actual income tax rate of the listed companies whose presidents or general managers had the working experience of governmental agencies were all lower than that of the companies whose executives were short of these working experiences, which explains that the government background of the executives can bring corresponding tax burden concessions to their enterprises. Wu Liansheng found, through researching the relation between state-owned shares and tax burdens of listed companies, that the higher the proportion of the state-owned shares was, the higher the actual tax rate of the company would be. The enterprise who holds a higher proportion of state-owned shares has assumed higher tax burdens.

106.2 Research Hypothesis

Tax preference (tax concession) is an important method of supporting the enterprise development. In the specific tax legislation, the tax preference is mainly carried out in the form of the regulations and rules promulgated by the departments such as the Ministry of Finance, State Administration of Taxation, etc. and even the provincial governments are authorized to complement detailed rules for implementation of some specific tax preferences according to local circumstances. A lower level and bigger arbitrariness for preferential policy exist in such legislation pattern, which may result in the unclear rules and large alterations. In such a case, the enterprises have a greater say in the social and political framework, which means that the enterprise can take advantage of such rule to get more tax benefits. Simultaneously, China is still the hierarchy society established in the light of "officialdom standard", and the higher the level (rank) of person in charge of the SOE, the more his/her political influence and political power will be and the bigger the tax preference support from the governments will be, and the enterprise will have a more favorable tax environment. As a result, the first research hypothesis of this paper is concluded:

Hypothesis 1 The SOE's political connection is of the effect of political rights. The higher the rank of person in charge of SOE, the bigger the tax preference support from the governments will be and the SOE's tax burdens reduce accordingly.

Political connection exerts an impact of political cost on the state-owned enterprises (SOEs). As to the person in charge of any SOE, his incentive to work not only is to increase the economic benefit of the enterprise concerned, but also includes the promotion cost paid to fulfill the political missions of the governments, which is reflected on the tax, namely, the SOE shall achieve the goal of political promotion of its person in charge by means of certain tax contributions. As the important indicator of measuring the performance or achievements of the SOE, the tax contribution of the enterprises to the governments become bigger, in which the political achievement of the person in charge of the SOE is also reflected. This plays the role of intensifying the tax contributions to safeguard the political promotion aspiration of persons in charge of the SOEs in China's economic development mode characterized by the administrative decentralization and fiscal responsibility system. Compared with the circumstance that the enterprises directly under the Central Government assume more social responsibilities, it poses a higher requirement on the tax contributions of local medium/small-size SOEs. As a result, the second research hypothesis of this paper is concluded:

Hypothesis 2 The SOE's political connection is of the effect of political cost. The lower the rank of person in charge of SOE is, the more intense its aspiration for political promotion will be and the SOE's tax burdens increase accordingly.

106.3 Research Design

106.3.1 Explained Variables

Consolidated corporate tax burden is an important indicator to measure enterprise business benefit and the level of tax burden. In general, final taxpayers of goods turnover tax including VAT are the consumers, but not the enterprises, so it is unreasonable to calculate the consolidated corporate tax burdens by adding the goods turnover tax. In this paper, the consolidated corporate tax burden is defined as the ratio between the direct taxes payable and the current-year operating income of the enterprise, including corporate income tax, property tax, stamp duty, etc. Taxes paid by the enterprise are from the actual expenditure of the corresponding taxes and fees paid by the enterprise in cash flow statement in its annual financial report.

106.3.2 Explaining Variables

Degree of political connection: there is a natural political relation between the SOEs and the governments, but such a relation is subject to a difference of closeness/distance. The management of the SOEs is similar to that of the government departments, namely, the president of the SOEs plays a decisive role, so only the president or general manager samples of the listed state-owned companies are chosen in this paper while selecting the samples of measuring the political connection. As to the judgment of the correlation degree, the official rank is exactly the final standard of measuring the political connections in China with "officialdom standard" ingrained. Generally speaking, the CPC committee officials, governmental agency officials, deputies of the national people's congress (NPC) and members of the CPPCC who are considered together the officials have very different political influences. The political influence and role of the officials working in the CPC committees and governments are significantly higher than that of the NPC's deputies and CPPCC's members. Even in the CPC committees and the governments, the political influence of the officials in different sectors or departments is different, too. The political influence of the officials working in economic sectors is significantly superior over the officials in other sectors. Moreover, the administrative ranking of the officials is the important factor of affecting the degree of SOEs' political connection because it can produce different political reputation and power. For this reason, sector principle and rank principle are applied to the assignment of political connection in this paper. The political connection for the same level in the economic sector will be increased by one level for the assignment according to actual administrative influence, for example, it shall be deemed that the political connection of the person in charge of the SOE who has not corresponding political ranking but only the identity of the NPC's deputies and CPPCC's members is weaker and it shall be assigned with 1 score (Table 106.1).

According to the research need, the following indicators of measuring the SOE's political connections are created in this paper:

SOE's political connection (Poli-con): if person in charge of the SOE is of the political identity and administrative rank, 1 score shall be assigned regardless of his/her administrative rank, otherwise 0 score shall be assigned.

Strength index of SOE's political connection (Polindex-con): the corresponding administrative rank of the person in charge of the SOE is taken as the assignment score. If president and general manager of the SOE both have the administrative ranking, the index is the sum of the two scores.

Strength and weakness of SOE's political connection degree (Polindex-qr): it is used to reflect the degree of SOE's political connection, which is the sum of SOE's political connection (Poli-con) and strength index of SOE's political connection (Polindex-con).

106.3.3 Control Variables

Regional factors: There is a stronger regional difference for the specific implementation of the corporate income tax, which is reflected on tax preference, tax

Table 106.1 Assignment standard for degree of political connection

Administrative ranking	Assignment score	Main posts or duties
Provincial/ministerial level	5	NPC's deputies, CPPCC's members, vice governors or above and vice ministers or above
Prefectural level/department level	4	Provincial NPC's deputies, provincial CPPCC members, prefectural officials, officials worked once in important sectors of the Central Government
County level/division level	3	Municipal NPC's deputies, municipal CPPCC members, county-level or division-level officials, officials once worked in provincial important sectors
Section level/bureau level	2	County-level NPC's deputies, county-level CPPCC members, section-level or bureau-level officials, officials once worked in municipal important sectors
Below section level	1	Persons in charge of township governments, officials once worked in county-level government sectors or below

collection and management, etc. Generally, it is the usual practice to conduct the economic division and comparison based on East China, Central China and West China. Furthermore, there is a relative particularity of corporate income tax policy in supporting the development of northeastern region in China, so it is divided into an independent region (area). Municipalities of Beijing, Shanghai, Tianjin and Chongqing directly under the Central Government as well as cities of Shenzhen, Zhuhai, Ningbo, Qingdao and Dalian which are specially designated in the state plan have a significant headquarter economic advantage and the income tax preferential policy is relatively particular, so they are divided into an independent region (area) for analysis. For this reason, East China, Central China and West China are divided as follows: Hebei, Shandong, Jiangsu, Zhejiang, Fujian (excluding Xiamen), Guangdong (excluding Shenzhen, Zhuhai and Shantou) in East China; Shanxi, Henan, Hubei, Hunan, Jiangxi and Anhui in Central China; Shaanxi, Gansu, Qinghai, Ningxia, Xinjiang, Sichuan, Yunan, Guizhou, Tibet, Guangxi and Inner Mongolia in West China.

Debt/Asset Ratio (LEV): the pre-tax corporate debt can be deducted from the calculation of corporate income tax to achieve the tax shield effect. The tax burden rate of the enterprise will be reduced accordingly while the financial leverage ratio becomes higher, and there is a negative correlation between them.

Returns on Assets (ROA): the tax payable for corporate income tax is calculated based on the premise of accounting profit and obtained by way of tax payment adjustment, and therefore, the accounting profit is still the foundation of paying income tax and affects the tax burden level.

Tax Year: the corporate income tax policy is obviously time-based, and tax rate and tax preference will be changed accordingly, which may result in the difference of consolidated tax rate in different years. Year 2008 is chosen as the base year for analysis in this paper.

106.4 Sample Statistics

In this paper, the listed state-owned companies (actual holding) of Shanghai and Shenzhen stock markets are taken as the research samples and year 2008–2009 is chosen as the research period. The following treatments are made on the basis of original samples:

1. Delete the data of financial and agricultural and forest companies. The financial data are inconsistent because the special accounting standards are applied to the financial companies; the special support is provided to the corporate income tax of agricultural and forest companies, which has a bigger difference from other sectors;
2. Delete the data of the enterprises with unusual financial data. This includes the enterprise samples of unusual financial indicators, for example, its actual tax burden is over 100 % or below 0; data of ST enterprises. 635 effective

observations are obtained in the final context. The data of SOE's political connections are manually collected by consulting the data of resume of persons in charge of the SOEs disclosed in their annual reports and rechecked and confirmed by searching the keywords in www.baidu.com. The WIND database for tax burdens are processed by SPSS17.0 software. There are 465 samples of political connections, accounting for 68 %. Most of persons in charge of the SOEs having political identities are officials delegated by the State-owned Assets Supervision and Administration Commissions (SASACs) of corresponding levels.

106.5 Empirical Test

In order to verify the research hypothesis proposed in this paper, the regression test model is established as follows:

$$\begin{aligned} Tax\,burdens = {} & \beta_0 + \beta_1\,POLITICAL \\ & + \beta_2\,SIZE + \beta_3\,LEV + \beta_4\,ROA \\ & + \sum_{i=8}^{11} \beta_i\,AREA + \sum_{j=12}^{13} \beta_j\,YEAR + \varepsilon \end{aligned}$$

where, the SOE's political connection (POLITICAL) covers the Poli-con, Polindex-con, Polindex-total and Polindex-qr. The definition of variables and the calculation methods are detailed in Table 106.2.

It is considered that the establishment of the SOE's political connection is closely related to the firm size. In general, the person in charge of the enterprise can win the corresponding administrative ranks or the qualification for promotion only after certain firm size has been achieved. As a result, the firm size also gives rise to the "effect of political cost" to the impact on the tax burdens, and the large-size SOEs are more likely to obtain the closer relations of political connections. The firm size was taken as the control variable in the empirical model, but this paper eliminated the impact of the firm size through the empirical test with the paired samples in order to enhance the credibility of political connection against the "political cost hypothesis" of the tax burden impact. 625 observations are divided into two groups according to the firm size in this paper, namely, close political connection and loose political connection. The former group includes 224 state-owned enterprises with a firm size of over 5,000 persons or governed by provincial SASACs or above; the later includes other 401 state-owned enterprises not included in the former group. 120 samples are taken at random from the enterprise group with close political connection, and then filter out in proportion of 1:1 the observations that are the most similar to the sample sizes of the enterprise with close political connection, in the same industry and the same year from the enterprise

Table 106.2 Variable definition and calculation methods

Name of variables	Symbol	Calculation method
Consolidated corporate tax rate	Tax burdens	Actually paid taxes/operating income
Political connection of the enterprises (whether or not)	Poli-con	1 score assigned for the condition with political connection and 0 score assigned for the condition without political connection
Strength index of political connections	Polidex-con	Score of administrative rank for the person in charge of the SOE
Total strength index of political connections	Polindex-total	Total of various scores of administrative rank for the persons in charge of the SOE
Strength and weakness of political connection degree	Polindex-qr	1 score assigned for the situation that total index is higher than the sample average, otherwise 0 score assigned
Firm size	SIZE	Natural logarithm of total operating income
Liability/asset ratio	LEV	Total debts/total assets
Return on assets	ROA	Net profit/total assets
Region/area	AREA	5 economic regions/areas, and 4 virtual variables
Year	YEAR	Year virtual variable

group with loose political connection, to finally form the paired samples of 240 observations, in which the observations of the enterprises with or without close political connection are half and half. Table 106.3 shows the test results of mean difference of paired samples. It can be seen that the mean difference Z of firm size in two groups is only 0.265 and no significant difference exists in the firm sizes, but the mean value of consolidated tax rate of the SOEs with close political connection is significantly higher than that of SOEs with loose political connection.

The statistics of main variables are detailed in Table 106.4. The consolidated corporate tax rate averages 6.827 %, with the minimum of 0.075 % and the maximum of 28.91 %, which indicates there is a bigger difference for consolidated corporate tax rates. The maximum index of political connection degree of the actual controller (person in charge) is 2, with an average of 2.165 and standard difference of 0.658. The maximum of total index of political connection degree is 10 and the minimum is 0, with an average of 2.535 and standard difference of 3.189, which indicates that there is also a bigger grade difference for the political connection of the enterprises. The Liability/Asset Ratio (LEV) of other financial indicators averages 30.204 % and the return on assets (ROA) averages 5.729 %.

Table 106.3 Test result of mean difference of paired samples

Sample group	Mean value of consolidated tax rate	Mean difference Z value	Sig. (two-tailed test)	Firm size mean value	Mean difference Z value	Sig. (two-tailed test)
Close political connection	5.502	4.055	0.001	21.070	0.265	0.624
Loose political connection	4.536			14.095		

Table 106.4 The main variable statistics

Variable	Sample	Means	Minimum	Maximum	SD
Tax burden	635	6.827	0.075	28.910	5.403
Policon	635	0.421	0	1	0.499
Polindexcon	635	2.165	0	2	0.658
Politotal	635	0.683	0	1	0.463
Polindex-total	635	2.535	0	10	3.189
SIZE	635	15.577	10.252	14.789	1.279
LEV	635	30.204	1.480	120.159	16.74
ROA	635	5.729	−24.49	85.030	8.405

106.6 Conclusion

Based on the state-owned enterprises (SOEs) of the listed companies in Shanghai and Shenzhen stock markets in 2008–2009, this paper researched the impact of the political connection on the tax burdens of the SOEs through empirical analysis. The research results show that the "effect of political rights" and the "effect of political cost" are simultaneously existed in the SOE's political connection. There exists the "effect of political rights" for the provincial SOEs or above due to the existence of corporate social responsibility, the relatively convenient availability of the tax preference policies and the relatively lighter tax burden of the SOEs. There exists the "effect of political cost" for the SOEs below the provincial level because the local governments have the strong demands for economic development and fiscal revenue assurance, the persons in charge of these SOEs have the natural impulse of paying the taxes and the tax burdens of the SOEs are relatively heavier. IF the person in charge of the SOEs has only the identity of NPC's deputy or the CPPCC's member, it cannot be completely translated into a valuable official rank.

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Chapter 107
Power Balance of Equity and Corporate Performance

Jian Su and Xiaoming Ji

Abstract Not many theories were about how the power balance affected the corporate governance. The paper investigates whether and how the power's balance can affect the performance of Japanese listed companies. With sample data of companies listed on Tokyo Stock Exchange, it was interpreted that Return on Assets (ROA) could be regressed on TOP1 (the radio of the largest shareholder), TOP2 (the ratio of the second shareholder) and TOP3 (the ratio of the third shareholder) respectively. The empirical results showed: firstly, TOP1 is negatively related to ROA; secondly, TOP2 is positively related to ROA; finally, TOP3 is negatively related to ROA. These results suggested that reducing the ratio of cross-shareholding, and enhancing the impact of the second largest shareholder are the effective ways to improve corporate earning.

Keywords Corporate governance · Cross-shareholding · Power balance

107.1 Introduction

Most of the equity theories believe, how to adjust the relationship of large shareholders and small shareholders is the key to the optimal ownership structure. However, in reality, the majority of the shares of listed companies game is not a

J. Su (✉)
School of Business Administration, Northeastern University, Shenyang, China
e-mail: sujian01@163.com

J. Su
Business Administration College, Shenyang University, Shenyang, China

X. Ji
Department of International Cooperation & Exchange, Northeastern University, Shenyang, China
e-mail: jxm@mail.neu.edu.cn

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fight between a major shareholder and minority shareholders, but several large shareholders' game. The power balance of equity is that the right to control corporations is shared by several big shareholders, and no big shareholder can control the corporation alone (Maury and Pajuste 2005). It is an efficient model of corporate governance. So the companies need an efficient system of power balance.

This paper investigates whether and how the power's balance can affect the performance of Japanese listed companies. With sample data of companies listed on Tokyo Stock Exchange, it was interpreted that Return on Assets (ROA) could be regressed on the ratio of the three largest shareholders respectively.

107.2 Power Balance Theories

In 1932, Berle and Means described the theory of the ownership structure optimizing. Since then, how to adjust the shareholding proportion of the large and small shareholders in order to achieve optimal corporate governance has been the focus of equity research. However, in 1990s, as many companies gradually transformed to be public companies, the competitions among large shareholders have become a common phenomenon in the enterprises.

McConnell and Servaes (1990) proved that internal shareholders cannot always reach a consensus. For example, when a son received the inheritance from his father, or a shareholder transferred his stocks, those new shareholders may become the block shareholders. Since they will be against the original shareholders, it is necessary to establish the power balance of equity (McConnell and Servaes 1990). Zwiebel (1995) gave the definition of the power balance system of equity. It means that the company is controlled by several large shareholders, and no large shareholders can control the company alone. The power balance system of equity is the best choice for the companies (Zwiebel 1995).

Pagano and Roell (1998) believed that while the developing enterprises need the support of funding, the original shareholders would worry that their rights of control would be diluted. Therefore, when the companies need finance, the original shareholders will consider both the development of the enterprises and the impact of their control (Pagano and Roell 1998). Pagano and Roell also believed that if outside shareholders kept large amount of shares, they would be hostile to the original shareholders. Bennedsen and Wolfenzon (2000) suggested the equity power balance system was decided by the alignment effects and formation effects of a number of large shareholders (Blanchard et al. 1993). The alignment effects were the production of many large shareholders' collusion. This collective conspiracy was more efficient than the single largest shareholders were. The high shareholding ratio can reduce the agency costs and increase the company value (Bennedsen and Wolfenzon 2000). Gomes and Novaes (2005) firstly discussed the behaviors of the largest shareholders and the larger shareholders groups, then proved the theory of optimal ownership structure. Gomes and Novaes believed that power balance would reduce the efficiency for two reasons, the equity effects and the compromise effects. Equity effect refers to the internalization of the enterprises' value as shareholders transferred their share and control rights. The compromise effect refers to the negotiation among larger shareholders.

Different from the theoretical research, we did not find the unanimous conclusion through the empirical research. By the empirical study, Short and Keasey (1999) found that it was universal phenomenon that no evidence showed that the second or third largest shareholders could always influence business policy. But Paolo (2002) suggest that the second largest shareholder could promote the performance of listed companies in Germany. Luc and Levine (2004) found that the second largest shareholder could promote the performance only if the gap between the largest shareholder and it was tiny.

107.3 The Model and Variables

In order to verify how large shareholders' power balance can influence company's business efficiency, we will use the fixed effect model to analyse panel data of companies listed on Tokyo Stock Exchange, with samples of 620 listed companies' 3-year financial data on the Tokyo Stock Exchange, which was 1860 samples totally. Since corporate governance could not affect the shareholding ratio directly, if we could find correlation of the shareholding ratio and performance, it will prove that the investors can affect the company policy by changing the shareholder's ratio.

1. *The Model*: In order to prove how the power's balance could affect the performance, we chose Return on Assets (ROA) to be the dependent variable. Z, the independent variable, is the large shareholding ratio. In the actual verification process, the largest shareholding ratio (Z) will be replaced respectively by the shareholding ratio of the first three largest shareholders (TOP1, TOP2 and TOP3). Demsetz and Lehn (1985) also verified the relationship of the ownership concentration and ROA by using the same method. In addition, in order to ensure the accuracy of the independent variables, we will add the control variables. In summary, our model is as follow:

$$ROA_{it} = Intercept + Control\,variables_{it} + \gamma Z_{it} + \varepsilon_{it}$$

$$\varepsilon_{it} = \theta_t + \omega_{it} \quad i = 1, 2, \ldots, N \quad t = 1, 2, \ldots, T$$

γ is the coefficient of independent variables;

ε_{it} is the error with fixed (time) effect;

θ_t is the fixed effect of the time of t years, we assume that every enterprise has the time effect;

$\boldsymbol{\omega_{it}}$ is the model error, $\omega_{it} \sim$ i.i.d $N(0, \sigma^2)$.

2. *Variables*: As the dependent variable, ROA can show not only the profit of the shareholders, but also the performance of the liabilities, which can fully reflect

the governance efficiency. Investors have different motivations. Only the efficient investors can improve ROA. Then ROA will be calculated as follow:

$$ROA = P_n/A$$

P_n: After-tax profit.

A: Book asset value.

Many studies suggest that the shareholding ratio of the large shareholders should have important impact on the operating policies and the efficiency. Therefore, the independent variables are the radio of the three largest shareholders (TOP1, TOP2 and TOP3). The data of the large shareholding ratio comes from the Electronic Disclosure for Investors' NET (EDINET), Japan. Since many factors could affect the governance efficiency, in order to ensure the correctness of the result, we will also introduce some control variables to be the independent variables of the model. Control variables include the asset-liability ratio (D/A), the logarithmic of the stock market price ($\log_{10}$V), the logarithmic of book assets ($\log_{10}$A) and the logarithmic of intangible assets ($\log_{10}$IA).

107.4 The Empirical Analysis

In order to find the relationship between the large shareholding ratio and the corporate governance, we will use listed companies' financial data of Tokyo Stock Exchange from 2007 to 2009. All the financial data is selected from the Nikkei Economic Electronic Databank System (NEEDS), and the data of large shareholding ratio comes from the Electronic Disclosure for Investors' NET (EDINET). Except financial firms, public utilities' firms, and part of the incomplete data, we collected 3-year data of 620 enterprises, which is 1860 samples totally. Table 107.1 is the statistical description, and Table 107.2 is the verified results:

We can find from Table 107.2, all control variables are significant at the 1 percent level. And the control variables can control the regression results. The asset-liability ratio is negatively related to ROA. It shows that when the profit of the company is low, the manager will solve the lack of funding through debts firstly, which is consistent with pecking order theory. The stock market price is positively related to ROA. Since investors dispose to companies with good

Table 107.1 Statistical description

	ROA	$\log_{10}$V	D/A	$\log_{10}$IA	TOP1	TOP2	TOP3
Average	0.04	10.18	0.44	2.12	0.21	0.09	0.06
Means	0.03	10.09	0.43	2.02	0.17	0.07	0.05
Standard deviation	1.18	0.63	0.22	0.98	0.16	0.05	0.03
Minimum	−2.41	8.88	0.03	0.00	0.03	0.01	0.01
Maximum	16.43	12.85	0.93	6.44	0.78	0.29	0.20
Samples	1,860	1,860	1,860	1,860	1,860	1,860	1,860

Table 107.2 The relationship between ROA and the shareholding ratio

	TOP1	TOP2	TOP3
Intercept	−1.68*	−2.00*	−0.87*
	(−14.84)	(−19.08)	(−5.73)
$\log_{10}V$	0.17*	0.18*	0.10*
	(2.90)	(17.30)	(7.00)
D/A	−0.09*	−0.11*	−0.04*
	(−3.57)	(−4.57)	(−6.39)
$\log_{10}IA$	0.16*	0.17*	0.07*
	(15.36)	(14.46)	(6.69)
TOP1	−0.75*		
	(−6.75)		
TOP2		0.67*	
		(3.01)	
TOP3			−2.86*
			(−3.15)
R^2	0.38	0.38	0.38
F	13.12	14.90	13.51
$N \times T$	1,860	1,860	1,860

Note * represents 1 % significantly. ( ) is T statistics

profitability, they could improve stock price. However, the companies with a higher stock price could get more chances of investing. That means the companies have low opportunity cost, and high profit. The analysis shows that the largest and the third-largest shareholding ratio are negatively related to ROA. However, the second largest shareholding ratio is positively related to ROA.

107.5 Conclusion

The power balance of equity was that the right to control the company was shared by several large shareholders, and none of them could control the company alone, which was an efficient model of corporate governance. We investigated whether and how the power balance could affect the performance of Japanese listed companies. With sample data of companies listed on Tokyo Stock Exchange from 2007 to 2009, it was interpreted that Return on Assets (ROA) could be regressed on TOP1 (the radio of the largest shareholder), TOP2 (the ratio of the second shareholder) and TOP3 (the ratio of the third shareholder) respectively. The empirical results show: firstly, TOP1 was negatively related to ROA; secondly, TOP2 was positively related to ROA; finally, TOP3 was negatively related to ROA. These results suggest that it could be more efficient, when the two largest shareholder ratios were infinitely close. The third largest shareholder was the arbitrage investor, whose shareholding ratio was negatively related to ROA.

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Chapter 108
Research on Current Situation Analysis and Solving Strategies of Large Inflows and Large Outflows of Telecom Customers

Yang Gao and Qun Yuan

Abstract In order to response the increased competition, reduce the economic losses caused by large inflows and large outflows of telecom customers, and enhance the quality of customer development, operators need to make efficient methods used to reduce customer churn rate and identify the re-access customer. The analysis of customer off-grid behavior characteristics and the motivation of re-access customers can effectively solve the problems, and help operators win the competitive advantage. Based on the current situation analysis of large inflows and large outflows of telecom customers, this paper briefly introduced the type of customer churn and the motivation of re-access customers, and focused on the solving strategies of external turn nets and the solving strategies of repeat network access. Due to the study of this paper, it provides a reference for the operators to develop marketing strategies and implement the function of customer churn warning.

Keywords Call fingerprint · Customer churn · Customer life cycle · Data mining · Large inflows and large outflows · Repeat network access

108.1 Introduction

With the completion of a new round of telecom restructuring, the competition between telecom operators become more intense. Rich diversity of promotional activities and continual drop of tariff packages lead to the phenomenon of large

Y. Gao (✉) · Q. Yuan
Kunming University of Science and Technology, Kunming, China
e-mail: gaogao0306@126.com

Q. Yuan
e-mail: 87765355yuan@163.com

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inflows and large outflows of telecom customers extremely serious. This not only consume the operators a lot of resources, but also result in significant economic losses. How to reduce churn rate, avoid repeat network access, and enhance the quality of customer development, has become the core issue for the operators to make strategic decisions. In this paper, by studying the type of customer churn and the motivation of re-access customers, the countermeasure of large inflows and large outflows of telecom customers can be obtained, and it will provide a decision support to maintain and retain customers.

108.2 Current Situation Analysis

Customer scale is the basis of all development. As we can see from the current market, the focus of the competition between telecom operators has been transformed from a quest for new customers to the competition for new customers and maintaining existing customers both coexist. These changes also reflect the higher customer churn rate and repeat network access behavior. The phenomenon of large inflows and large outflows of telecom customers has extremely serious. According to this situation, from the type of customer churn and the motivation of re-access customers to research strategies for customer retention and find solutions to enhance the quality of customer development.

108.2.1 The Type of Customer Churn

The type of customer churn can be summarized as follows:

1. *External turn nets* The charges of original operator is too expensive, switch to another operator's package seems to be more suitable, or one operator aggressively launches a number of promotional measures, some customers give into temptation, and switch to other networks, then leave the original operator.
2. *Internal turn nets* Switch to other brand within the same operator. Because operator rolls out more preferential access network measures to one consumption level customers, in order to reap the benefits, customers abandon the original phone card and buy a new one, namely repeat network access.
3. *Completely exit* Some customers no longer use mobile phones.

Known from the above type of customer churn, for the original operator, external turn nets resulted in an absolute loss of customers, internal turn nets caused the waste of phone number resources and the rising cost of marketing management. Customer churn, on the one hand, declined the operator's revenue, on the other hand, caused a large number of phone number resources occupied for some time.

108.2.2 The Motivation of Re-Access Customers

For the same operator, although the number of new customer is large, but due to the existence of a large number of off-grid customers, this greatly reduced its actual net increase customers. New customers have a very serious inflated, of which a large number is re-access customers. This inevitably caused the waste of all kinds of marketing resources.

There are many reasons for causing a lot of re-access customers, which can be listed as follows (Li 2007):

1. *Exist a large number of tariff-sensitive customers* When the new tariff package appears or some kind of package appears privilege, the tariff-sensitive customers will turn net inside. Usually this part of the customers has lower Average Revenue Per User (ARPU), and little dependence on the phone number.
2. *Part of the marketing policies affects each other* There is a conflict between the new market policies and the stock market policies. The new marketing strategy has an impact on the existing tariff packages, which makes the original tariff packages customers move to a new one.
3. *Exist a lot of inaccurate positioning customers* For new customers, there is no suitable analytical tools to analyze and accurately identify their requirements, so this part of the customers rejoin the network after a very short period of time to select the more suitable brand or package for their own.
4. *Lack of effective means of control* For repeat network access customers, in particular, frequently delinquent customers, operators lack of effective means of control to avoid customers to rejoin the network.

For operators, a large number of re-access customers will cause a lot of profit loss: a large number of marketing resources of invalid consumption, card number resources, SIM card costs, the increased cost of channel sales, phone number commission, agent fees, and the business risk of malicious delinquent, and so on.

108.3 Research on Solving Strategies of External Turn Nets

As the application of Customer Relationship Management (CRM) theory, mainly from the following aspects to take measures.

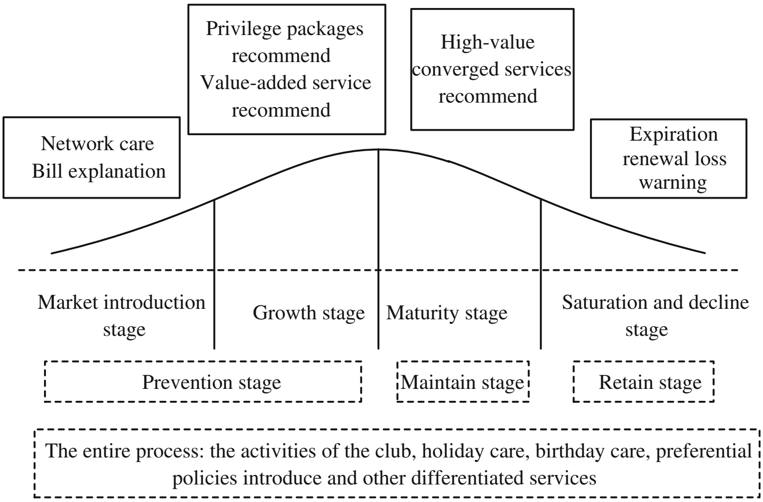

Fig. 108.1 Customer retention of the whole customer life cycle

108.3.1 Throughout the Customer Life Cycle to Implement Customer Retention Strategy

Through data mining, the demand characteristic and variation of the online customers can be grasped, and then take targeted retention means to increase customers stickiness and the cost of off-grid and achieve the purpose of customer retention. According to the division of the various stages of the customer life cycle to carry out the customer retention work (Ma 2010), as shown in Fig. 108.1.

108.3.2 Classify Customers by Customer Brand and Customer Value

According to the integrated value of the customer, the stages of life cycle and the customer brand to segment customers. Then carry out the classified retention. Take China Mobile Communications Corporation (CMCC) for example, as shown in Fig. 108.2.

From Fig. 108.2 we can get the following conclusions (Li 2005):

1. Make cost decision of customer retention by the judgment of customer value.
2. Determine the key work of customer retention by the judgment of customer life cycle.
3. Combine customer value with life cycle to judge the profitability and health of customer groups in different brands and review the accuracy of the brand positioning and market operations.

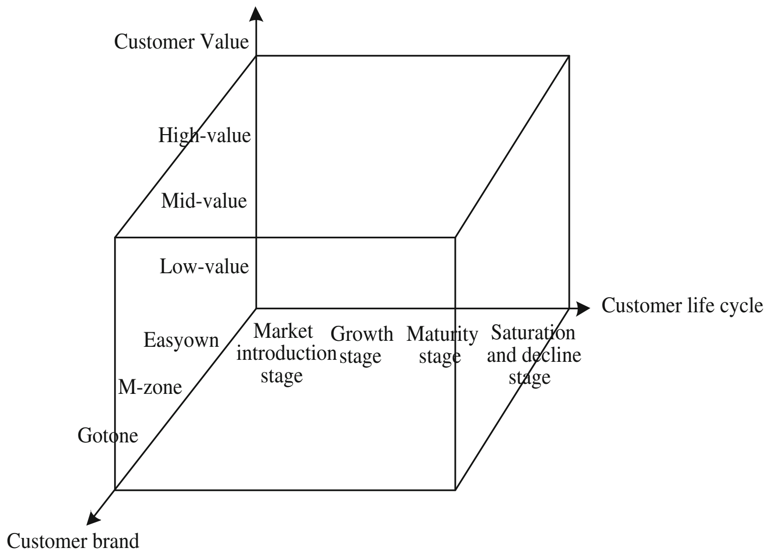

Fig. 108.2 Classification model of customer value, customer brand and customer life cycle

4. Meanwhile, strengthen the control of the rate of loss of low-end customers, and ensure that the overall churn rate and customer development costs continue to decline; enhance customer retention of the key customer of the high-value, and improve the overall profitability of the online customers.

108.3.3 Establish Customer Credit System

How to assess customer credit? Zhang and Meng (2010) from the perspective of combinatorial optimization, depended on the establishment of credit scoring models, proposed a customer attributes domain credit weight distribution algorithm which based on Ant Colony Algorithm (ACA). Zhang and Meng (2002) used a genetic algorithm to obtain the weight of attribute credit, and then through the initial credit formula, got the initial credit value of each customer. Zhao and Mu (2006) applied the Markov Blanket Bayesian Classifier (MBBC), built a customer arrears prediction model, and by expanding the probability, indirectly got the customer credit. Huang (2008) achieved a measure of customer credit by using the Analytic Hierarchy Process (AHP). Yang and Kuang (2008) the Artificial Immune Algorithm to establish a credit rating for customers.

Combine the above-mentioned studies with the customer actual situation of online duration and consumption levels to establish customer credit system. Then according to the customer credit system, we can give customers an appropriate reward, which could enhance customer satisfaction and loyalty and reduce the possibility of transfer network.

108.4 Research on Solving Strategies of Repeat Network Access

108.4.1 Identify Re-Access Customers

In order to solve problem of repeat network access, the first step is how to identify re-access customers.

The traditional repeat network access identification method purely identify by International Mobile Equipment Identity (IMEI) information. Li et al. (2006, 2007), He (2009) proposed a repeat network access identification algorithm, which based on the call fingerprint identification. The IMEI identification is more suitable for the large amount of data. Call fingerprint identification has a high accuracy, but it consumes relatively larger resources, also needs higher hardware requirements for data calculation and identification process. Both have advantages and disadvantages, so we need to combine the actual situation for use.

Liu et al. (2009) presented an algorithm based on the Term Frequency-Inverse Document Frequency (TF-IDF) weights and Cosine-Like algorithm to determine whether several cards are used by a single user. It can provide a more accurate judgment basis for telecom operators to forecast business trends and avoid the risk of user development in time.

108.4.2 Solving Strategies of Repeat Network Access

1. *Coordinate marketing strategies and strengthen the supervision of channels* (Asia Info 2009)

Operators should be timely adjust marketing strategy and policy, monitor the impact and negative effect between the marketing policy and packages, cancel or slow down the introduction of adverse packages in time and scope. Before the launch of the new marketing policy and packages, operators should carry out effective assessment.

Monitor all types of marketing channels, especially the approved card channels and final channels, in order to prevent the threshold drop of customers join network and other unreasonable behaviors.

2. *Strengthen the management of the flea customers and one-time disposable card customers* (Asia Info 2009)

By increasing the card fee threshold to increase the cost of customer repeat network access and reduce the number of repeat network access customers.

Identify and monitor the behavior characteristics of the flea customers and one-time disposable card customers, infer the consumer psychology of these customer groups, and then implement targeted bundled marketing and market control.

3. *Analysis customers pointedly and guide the inappropriate positioning customers in time*

The new customers have some questions that position is not accurate or package is not suitable. For such customers, use the appropriate analysis tools, such as cluster analysis, to extract feature, and guide comb pointedly. With further number portability and the implementation of the policy of package alternative, new customer can have a way to try out the package, and then achieve an accurate positioning results.

4. *Enhance system support*

Strengthen the integrity of customer information. Enhance the function of off-grid warning, it can have an effective identification and warning on the flea customers and disposable card customers.

Chen et al. (2009) shows the application of web data mining technique in competitive intelligence, which has some guidance to obtain basic information and contacts ring information of the customers. He (2007), Zhang (2011) mention the design method of repeat network access analysis system. Then combine with the business analysis system, it can has an early warning of repeat network access customers and guidance for marketing strategy.

108.5 Other Strategic Proposals

108.5.1 Analysis of the Source of New Customers and the Whereabouts of the Off-Grid Customers

By the analysis of the source of new customers and the whereabouts of off-grid customers, the source and direction of the vast majority of customers can be identified, which can make operators saw the problems that exist in the customer development process.

From a technical point of view, operators can analyze and mine the customer's call characteristics, using terminal characteristics and personal information. Repeat network access algorithm and competitors exchanges circle matching algorithm as the core, find the different sources and directions of the customers outside the customer life cycle. Then provide help for business staff to learn more about the overall composition of new and off-grid customers and different customer groups' characteristics, meanwhile provide support for precision marketing and fine management (Ni 2010).

108.5.2 New Customers and Existing Customers Tied for Consideration

If launch marketing case for new customers, especially because of the needs of the competition carry out the new tariff, the impact of this new tariff on the original of this grade consumer customers must be considered. In other words, it is necessary to consider new markets but also the existing markets. The easiest way is launch a reasonable promotion measures and implement the bundling of a longer period of time for the existing markets. At the same time, carry out the new tariff, but had better do the appropriate calculation assessment to determine their specific implementation of the scale and intensity.

108.5.3 Increase the Bundling of New Market

Exchange for customer scale with costs. After the bundle, the customer churn rate decreased, accordingly, market development costs reduced.

For example, suppose a customer is highly active customers. On the market, the card number with 100 yuan bill just only sells for 40 yuan. The operators launch the new marketing activities for the new network customers that pre-store 400 yuan bill will obtain the other 400 yuan bill, and the bill will be returned of 40 yuan per month, continued to be returned of 20 months. This, at first glance, input more costs, the return has doubled. However, suppose not to do so, after the customer access network, the APRU is 50 yuan a month, we can imagine the customer will access network once again two months later. During 20 months, even if repeat network access operates in the same operators, it needs to rejoin network 10 times, each time operators will pay 70 yuan remuneration to the agent, and then remuneration cost is 700 yuan, which is more than the return of 400 yuan. (It contains an assumption that this customer has these features customers through market segmentation.)

108.6 Conclusion

Through research on current situation analysis and solving strategies of large inflows and large outflows of telecom customers, we can know that, by the analysis of the customer's behavior characteristics inside and outside of the life cycle process, the operator can take targeted marketing measures to reduce customer churn rate. Meanwhile, by enhancing the recognition accuracy of repeat network access,the function of customer churn warning can be implemented. What's more, it will provide a decision support to maintain and retain customers and a reference for the operators to develop marketing strategies.

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Chapter 109
Research on Risk Assessment of the Equipment Maintenance Contractor Support

Hua Yang, Chao-jun Ji and Qiao-yun Wu

Abstract With regard to many uncertain factors which the process of military equipment maintenance support undertaken by contractors exists, this paper focuses on analysis and assessment of contractor support risks. Firstly, the whole procedure of the contractor support is formal described. Eight risk factors are identified through three aspects, including the army, the contractor, and both concerned parties. Secondly, a Bayesian Network diagram of these risk factors is constructed. Through an example, it has demonstrated the forward reasoning process of equipment maintenance contractor support risks, with using Bayesian Networks rational arithmetic. In order to control the most influencing risk factors, the sensitivity of different risk factors is finally analyzed. This method to identify, classify, and assess risks is useful for the army to prevent risks from occurring.

Keywords Bayesian networks · Contractor support · Equipment maintenance · Risk identification · Risk assessment

109.1 Introduction

The equipment maintenance contractor support is an effective strategy for the army, which can not only reduce maintenance cost of equipment, but also make up own maintenance support force scarcity. The U.S. army is actively pushing forward contractor support, through developing public–private maintenance cooperation, singing all types of support contracts, and strengthening the combat readiness level of contractor during peacetime or wartime (Cai et al. 2011). With the U.S. army advanced experience for reference, our army pays more attention to

H. Yang (✉) · C. Ji · Q. Wu
Department of Equipment Support, University of Military Transportation, Tianjin, China
e-mail: liuzesheng_1999@sina.com

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research equipment contractor support theory and practice. Ke et al. (2011) researched contractor synergy support system composition in the process of disaster relief. Bao et al. (2010) constructed the assessment index system of contractor's effectively technical service. Zhang et al. (2011) studied the gist, content and method of incentive mechanism to contractor. Liu et al. (2010) explored the implementing steps of performance-based contractor support. But, existed literatures about the equipment maintenance contractor support risks were less studied.

The objective of this paper is to study the army equipment maintenance contractor support risks. We consider a situation, in which the army offers equipment maintenance needs to external contractors who assist the army for scheduling and performing the military equipment maintenance missions, whenever on peace or on war. This situation is complicated and dynamic, because the army and contractor have the inconsistency of targets, the asymmetry of information, and face the uncertainty of environmental factors. Some potential risks maybe exist (Levery 1998). It is increasingly recognized by army commanders that the effective and rational management of contractor requires a risk-based strategy (Mohammad and Jamal 1991). Therefore, it is an urgent to research the management and control theory and means of contractor risks.

109.2 The Process of Equipment Maintenance Contractor Support Analysis

The process of the equipment maintenance contractor support is divided into four stages: preparing stage, signing stage, implementing stage, and delivery stage, as shown in Fig. 109.1 (Mak and Picken 2000). Risks are influenced by many factors which come from different maintenance support operations of each stage.

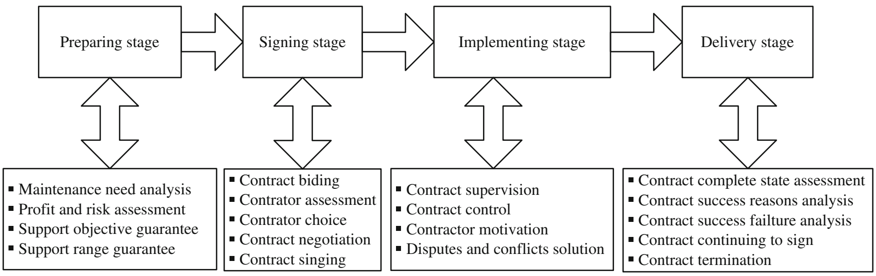

Fig. 109.1 The process of equipment maintenance contractor support

109.2.1 Preparing Stage

When the army sets about adopting equipment maintenance contractor support, it is the first thing to establish guaranteed support objects. Then, the army needs to analyze the demand of equipment maintenance services, and ascertain the limit of contractor support tasks. An appropriate business relation between the army and contractor can be oriented. The benefit and risk assessment of the contractor support are developed.

109.2.2 Signing Stage

The army should establish a special organization to manage the affairs of contractor support, including of bidding contract, supervising contractors et al. After defining maintenance need, the army could strictly review and compare the different ability of various contractors. By public bidding or inviting bidding ways, the army is very look forward to choose the contractor with relatively high quality service. A maintenance support contract is finally signed through negotiations between the two sides at terms of the contract.

109.2.3 Implementing Stage

In order to effectively ensure the maintenance mission with high quality, the army must pay attention to supervise the contractor's operations during the equipment maintenance implementing process, and review the investment cost to contractor maintenance service. At the same time, the army should establish incentive mechanism that can ensure the contractor to obtain a certain profit. The army can also give an economic punishment to the contractor who can't provide high-level services in time. Under the serious situation, the army can rescind the contract.

109.2.4 Delivery Stage

At this stage, the army needs to do four things: implementing dynamic management to contractors, assessing the contractor achievement, analyzing the success or failure contractor support's reasons, and determining continue to sign or terminate the interrelation at present.

109.3 Identification and Classification of the Equipment Maintenance Contractor Support Risks

Various potential risk sources can be classified into three categories, including the contractor, the army and the business between them. By considering these categories separately, one can develop a detailed classification scheme (Massimo et al. 2004).

109.3.1 Source Risk About the Contractor

- Opportunism Risk

In order to pursue own maximal benefit, the contractor provides incertitude information with teleology and strategy. Under the condition of asymmetric information, the army has no enough ability to identify the alternative contractors' true ability. When the number of contractors is less, it makes the army excessively to depend on the contractor. If having psychology of gaining more profit, certain contractors purposively provide illusive and distorted information of their ability for the army. As a result, it makes the army choose contractors with bad service. An adverse selection behavior would happen.

- Capacity Risk

For the maintenance need of the high technology and strong special degree equipment, there are sharp difference between practical maintenance technology level of the repairmen and maintenance technology level promised by contractor. The army's requirement of equipment maintenance can not be satisfied. Furthermore, because the contractor has some fault on maintenance skills and scarcity knowledge of the army equipment maintenance operation and goal, it is easily making equipment maintenance time delay. The quality of equipment maintenance can't be guaranteed. So, the army expose under risks. Finally the army equipment maintenance support efficiency would be influenced.

- Moral Risk

The relationship between the army and the contractor is fixed by the contract. The contractor should undertake equipment maintenance operation according terms of the contract. But, the army has limitations to supervise the process of the contractor's maintenance organization and implementation. It can't also get direct reports from the contractor. During the process of contract execution, this kind of situation can possibly make the contractor to do immoral behaviors, such as the behavior of hiding maintenance details, driving up the cost of maintenance, slacking the maintenance quality management and using bad spares.

109.3.2 Operation Risk About the Army

- Finite Rational Risk

No further investigation and research on market, army commanders fail to fully grasp a great amount of effective information from contractors, and believe some contractors' unrealistic propaganda. Because of lacking knowledge of contract signing, implementing, and management, the army commanders don't understand complexity of contractor support. Furthermore, the army commanders have no enough ideas to goals of the equipment maintenance contractor support and market environment of contractor. In the end, the army hasn't fully material preparation for contract signing. It is easy to trigger decision-making risk in contractor choice, contract supervision et al., by which unilateral decision manifested.

- Contract Constraint Risk

Because of having cognitive limitation and facing incertitude environment, the army commanders have difficulty to predict all various problems of the contractor support process. If the army hasn't adequate preparation for contract negotiation, including the level of contractor skill and service, information of contractor hidden cost, and so on, the army is easy to fall into a contract trap. The situation that the contract terms don't clearly define the army equipment maintenance needs, contractor's rights and duties, contractor support targets could happen. There may be potential risks for the army in equipment maintenance quality and efficiency, maintenance need flexibility, maintenance cost control and contractor internal information.

109.3.3 Cooperation Risk Both Sides

- Transaction Locking Risk

Once contract is signed, the army invests a large amount of specialized assets to the business between him and the contractor. When the army isn't satisfied with the maintenance service quality of the selected contractor, the army can get rid of the relationship of trade with contractor by paying transfer cost. Therefore, the contractor may use "trade lock" effect on contract execution, making the army face the dilemma that accepting the bad level of contractor support. The "trade lock" risk directly leads to the rising cost of the contract negotiations and decision-making, even causes some new costs, such as the cost of choosing new contractor's.

- Communication and Coordination Risk

Since the army and contractor have some difference on strategic objective, management idea and culture construction, it is urgent need to healthy communication and coordination mechanism with symmetrically exchange information. Otherwise, it is easy to cause some bad effect on the army, such as little information of equipment maintenance collecting from the contractor, single side information communication network from the army to the contractor at implementing stage, and the faultiness summary or unreasonable assessment of contractor support at delivery stage. Communication barriers are easy to happen, even leading to the termination of the contract, when contractor support is at signing stage, implementation stage or management stage.

- Afterwards-Cost Risk

During the contract implementation stage, some faulty contract items need to be remedied or perfected, which can cause the transaction cost and produce the contract repair cost. In order to accurately assess the contractor performance, the army needs to supervise the contractor, which will increase the supervisory cost. Sometimes, certain terms of the contract need to be interpreted by one side or both sides. It will cause bargaining negotiation, which can bring the dispute and lawsuit cost. Therefore, the afterwards-cost risk is very possible to occur.

109.4 Bayesian Networks Description

Bayesian Networks is an important tool about uncertain problems (Ye et al. 2007). A Bayesian Network which has N nodes can be denoted by the duality group $<G, P>$. G is used to denote a directed cyclic graph, consisting of a series of nodes $V = \{1, 2, 3 \cdots n\}$ with directed edges. On the graph G, node i means a random variable $X_i (i \in V)$. The parents of node i are the variables corresponding to its immediate predecessors. Directed edges which connect the parents of node i and node i show dependence relation of both nodes. Node $i (i \in V)$ is called a non-root node. Nodes, which have child nodes but no parents, are called by root nodes. Because each root node is irrelevance, the probability distribution function associated with root nodes is called an edge distribution function, which also called the prior probability. According to the non-root node dependence condition hypothesis, the probability function of no-root nodes is called a conditional probability distribution function, remembered as $P(X_i, \pi(X_i))$. The variable $\pi(X_i)$ is the set of parents of node i. Considering all nodes represent the random variable on a Bayesian Network, the joint probability distribution function of a set of variables $\{X_1, X_2, \ldots, X_n\}$ is:

$$P(X_1, X_2, \ldots, X_n) = \prod_{i=1}^{n} P(X_i / \pi(X_i)) \tag{109.1}$$

109.5 Example Application

109.5.1 Bayesian Network Construction

Figure 109.2 describes the proposed classification scheme of the equipment maintenance contractor support risks based on a Bayesian Network diagram.

109.5.2 Prior and Conditional Probability computation

The risk event occurrence probability of each node is set as five levels: low (0–20 %), and relatively low (20–40 %), medium (40–60 %), relatively high (60–80 %) and high (80–100 %).

Table 109.1 gives the risk event occurrence prior probability values of root nodes that come from different experts. The variable $\mu_i (i = 1, 2, \ldots, n)$ represents the probability value, as shown in Table 109.1. The relative weight values of various experts, denoted by $C_i (i = 1, 2, \cdots, n)$, are shown in Table 109.2. According to the formula:

$$P = (c_1, c_2, \ldots, c_n) \cdot (u_{i1}, u_{i2}, u_{i3}, u_{i4}, u_{i5})^T \tag{109.2}$$

we can fuse the probability distribution value and every expert's weight ratio into the prior probability value of root nodes, as shown in Table 109.3.

Similarly, experts evaluate the conditional probability values of source risk (B), operation risk (C), cooperation risk (D), contractor support risk (A). On the base of synthetically consideration relative weight ratio among experts, we can also draw data as shown in Tables 109.4, 109.5, 109.6, 109.7.

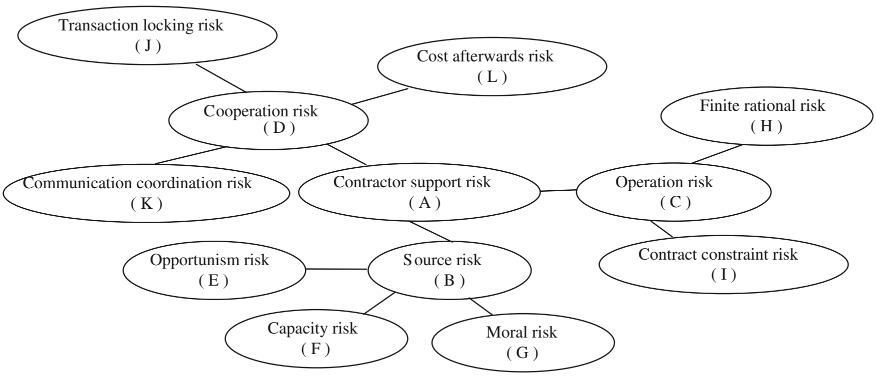

Fig. 109.2 A Bayesian network diagram of equipment maintenance contractor support risks

Table 109.1 Prior probability values of root nodes

Node	Expert1	Expert2	Expert3	Expert4	Expert5
E	0.5	0.6	0.4	0.6	0.6
F	0.5	0.5	0.7	0.8	0.5
G	0.2	0.3	0.2	0.4	0.5
H	0.7	0.6	0.7	0.7	0.7
I	0.5	0.5	0.6	0.5	0.5
J	0.7	0.7	0.6	0.7	0.7
K	0.9	0.9	0.9	0.8	0.8
L	0.6	0.8	0.6	0.7	0.8

Table 109.2 Expert relative importance weight values

	Expert1	Expert2	Expert3	Expert4	Expert5
Relative Importance	0.25	0.17	0.18	0.21	0.29

Table 109.3 Prior probability values of root nodes

Node	Occurrence probability of risk event	Nonoccurrence probability of risk event
E	0.722	0.278
F	0.322	0.678
G	0.38	0.62
H	0.328	0.672
I	0.49	0.51
J	0.38	0.62
K	0.222	0.778
L	0.28	0.72

Table 109.4 Risk conditional probability values of B

E	F	G	$P(B = true/E;F;G)$	$P(B = false/E;F;G)$
1	0	0	0.424	0.586
0	1	0	0.181	0.819
0	0	1	0.328	0.672
1	1	0	0.478	0.522
0	1	1	0.478	0.522
1	0	1	0.494	0.506
1	1	1	0.715	0.285
0	0	0	0.117	0.883

109.5.3 Bayesian Network Reasoning

Using the data in Tables 109.3 and 109.4, we can take the prior probability values of the root node E, F, G and the conditional probability values of the non-root node

Table 109.5 Risk conditional probability values of C

H	I	$P(C = true/H; I)$	$P(C = false/H; I)$
1	0	0.443	0.557
0	1	0.715	0.285
1	1	0.335	0.665
0	0	0.146	0.854

Table 109.6 Risk conditional probability values of D

G	K	L	$P(D = true/G; K; L)$	$P(D = false/G; K; L)$
1	0	0	0.341	0.659
0	1	0	0.319	0.681
0	0	1	0.216	0.784
1	1	0	0.366	0.634
0	1	1	0.384	0.616
1	0	1	0.377	0.623
1	1	1	0.713	0.287
0	0	0	0.119	0.881

Table 109.7 Conditional risk probability values of A

B	C	D	$P(A = true/B; C; D)$	$P(A = false/B; C; D)$
1	0	0	0.341	0.659
0	1	0	0.344	0.656
0	0	1	0.233	0.767
1	1	0	0.316	0.684
0	1	1	0.401	0.599
1	0	1	0.352	0.648
1	1	1	0.696	0.304
0	0	0	0.144	0.856

B into the whole probability formula. The risk occurrence whole probability of source B is computed. That is:

$$P(B = true) = \sum P(E; F; G; B = true) = 0.415$$

The risk nonoccurrence whole probability of source B is as followed:

$$P(B = false) = 1 - P(B = true) = 0.585$$

Similarly, we can get whole probability of the C, D and A risk occurrence and nonoccurrence. As shown in Table 109.8, the risk of A is at a relatively low level.

Table 109.8 Whole probability values of non-root nodes

Node	Risk occurrence	Risk nonoccurrence
B	0.41467	0.58533
C	0.349366	0.650634
D	0.259787	0.740213
A	0.289873	0.710127

109.5.4 Sensitivity Analysis

To effectively mitigate and control risks, it is important to analyze the risk event sensitivity of root nodes (Edmundas et al. 2010; Gao 2009; Obaid et al. 2005; Rajesh and Uday 2004; Anisur 2010).

When α_i is the sensitivity factor of root node i, the following formula (109.3) is used to compute root node i's risk event sensitivity:

$$\alpha_i = \frac{\gamma_i}{\gamma_{\max}} \tag{109.3}$$

In the formula (109.3), γ_i denotes the relative whole probability value of non-root node A, when the risk event of root node i doesn't occur. The variable γ_i is computed by formula (109.4).

$$\gamma_i = (P_T - P_{T,i})/P_T \tag{109.4}$$

The variable $\gamma_{\max}$ of formula (109.3) denotes the biggest element of the set $\gamma(\gamma = \{\gamma_1, \gamma_2, \ldots, \gamma_m\}^T)$. In the formula (109.4), the variable P_T and $P_{T,i}$ denote the risk occurrence and nonoccurrence whole probability of non-root node A, when the risk event of root node i occurs and doesn't occur. For example, when the risk event nonoccurrence probability of root node E of Table 109.3 is set as 1, according to the Bayesian Network forward reasoning, we can calculate the value of $P_{T,i}$, that is 0.2648. Then, we can conclude γ_E of the root node E by using the formula (109.4). Similarly, when setting the nonoccurrence probability of other root nodes as 1 by turns, the different variable γ_i can be computed. Using the formula (109.3), the risk event sensitivity analysis result of root nodes are as shown in Table 109.9. It is easy to find from Table 109.9 that the opportunistic risk (E) has the highest relative importance to the contractor support risk(A), of which value is 1, followed by root node H, I, G, J, K, L.

Table 109.9 Root node risk event sensitivity analysis

	E	F	G	I	K	H	J	L
α_i	1	0.195	0.321	0.598	0.148	0.634	0.293	0.112

109.6 Conclusion

In this paper, we have investigated the subject of equipment maintenance contractor support risks. The process of equipment maintenance contractor support is divided into four stages. Three risk factors and eight sub-factors is analyzed and summarized. Using a case, it gives steps of the equipment maintenance contractor risk assessment by the Bayesian Network model. In order to compare different root nodes influencing on the final equipment maintenance contractor support risk, we compute the relative sensitivity of various root nodes. This paper provides a practical ways for the army commanders to quantify and control of contractor support risks, so that the army can accelerate contractor support into execution.

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Chapter 110
Research on the Informatization Mode of Solid Waste Outsourcing in the Eco-Industrial Park

Jian Li, Jiao-jiao Yin and Ying-chun Wang

Abstract With increased attention to the industrial park of the ecological development, the park's solid waste outsourcing is an urgent problem. By the analysis of the necessity of solid waste outsourcing information, in the paper we put forward the Horizontal-intermediary virtual integration outsourcing model from the material flow concentration point of view, then systematically analyzed the model and the case of Hua Ming Industrial Park, discussed the advantages of the informatization model characteristics. Finally, we probed into the implementation suggestion of eco-renovation about the old industrial base and new construction of Eco-industrial Park.

Keywords Informatization · Material flow concentration · Outsourcing · The horizontal–intermediary virtual integration

110.1 Introduction

With the continuing destruction of the ecological environment, the modern industrial system needs to be changed from the traditional "linear" mode of production to the eco-industrial system model. In order to reduce costs and optimize the industrial chain, more and more enterprises consider the core business areas, while the outsourcing of solid waste has gained considerable public concern recently (Nilsson et al. 1995; Hines and Rich 1998; Gottfredson et al. 2005).

J. Li (✉) · J. Yin · Y. Wang
School of Management, Tianjin University of Technology,
Tianjin, China
e-mail: lijian1126@126.com

J. Yin
e-mail: yinjiao1025@126.com

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Yang etc. had considered that outsourcing has become an important business principle and more efficiently by external suppliers to provide products or services will become a competitive advantage (Yang et al. 2007). Dapeng etc. had discussed the resources outsourcing network path and described the trend & demonstration of the mode (Dapeng et al. 2005). Based on the waste information exchange model, Wang had established a waste information management system of enterprises, regions and communities (Wang 2008). According to the experience of other countries, Li etc. had put forward three kinds of patterns about the outsourcing in Environmental Management (Li et al. 2005). Rolland had analyzed the difference between hazardous waste and general waste in the offshore outsourcing (Rolland 2007). Jianhua etc. had reviewed the research progress of outsourcing from the concept of outsourcing, the structural characteristics, the resource hierarchy of outsourcing enterprise, the goals of outsourcing and enterprise performance (Jianhua et al. 2003). Kara had analyzed the waste electrical and electronic equipment outsourcing business evaluation (Kara 2011).

The former is not enough to make a deep research in the outsourcing of solid waste in the eco-industrial park information model. Therefore, we have better to make a deep research in the mode of outsourcing information technology and try to provide a theoretical reference in the ecological development of the industrial park.

110.2 The Necessity of Solid Waste Outsourcing Information

With the rapid economic development, resource and environmental issues are increasingly becoming the bottleneck of the social sustainable development. According to the concept of circular economy, it is good to solve the bad effects of environment by turning the "waste" into renewable resources and make the "waste" into a resource complement.

With material consumption and environment pollution, it forces people to propose new approaches to reduce the consumption of material and energy and strengthen environmental protection and measures. Solid waste outsourcing will help the company solve the problems of waste brought. The process from the systems and information technology points could provide a method for improving the efficiency of outsourcing.

110.2.1 Extensive Information Management of Industrial Solid Waste

At present, the regional administrative departments only count some kinds of solid wastes such as blast furnace slag, coal ash powder and hazardous waste from the industrial solid waste environment statistics. According to local arguments, the kind of method not only unclearly express the recycling production and emission of glass, packaging materials and metal, but also incompletely gather the statistical information about regional industrial solid waste reduction and recycling.

110.2.2 Imperfect Resource Recovery System

Compared with the countries which have better construction of circular economy such as Japan, Germany, resource recovery systems are greatly confusing in China. They seriously restrict the sound development of the resource recovery industry and circular economy industrial chains. Professional companies are facing a lot of problems such as the insufficient of the waste source, the cost of waste acquisition, the lack of technology and the obstacles of the waste recycling channels.

110.3 Analysis of Outsourcing Informatization Mode

110.3.1 The Horizontal-Intermediary Virtual Integration Model

Combining with some characteristics of the solid waste outsourcing of the ecological industrial park, we analyze the informatization mode of the Horizontal-intermediary virtual integration. Employers and contractors upload their outsourcing information to a comprehensive information management system. According to the information provided by the employers, the resources information systems in relation to contractors will be connected by the manager who is from the centralized station. The contractors are authorized to enter the appropriate database, sharing information with the employers. The manager collects and classifies the information of the contractors and then matches the former with the employers' demand information. At last, let the both sides negotiate the relevant matters. The transaction contracts are provided by the centralized station and they should confirm them (Fig. 110.1).

110.3.2 Analysis of the Advantages

This mode is from a macro perspective to analyze the process of the solid waste outsourcing in the Eco-industrial Park. Compared to the single horizontal virtual integrated model, the advantages of this model are: the employers do not have to build an outsourcing resource information system by themselves and the both sides will reduce the burden of the demand and supply.

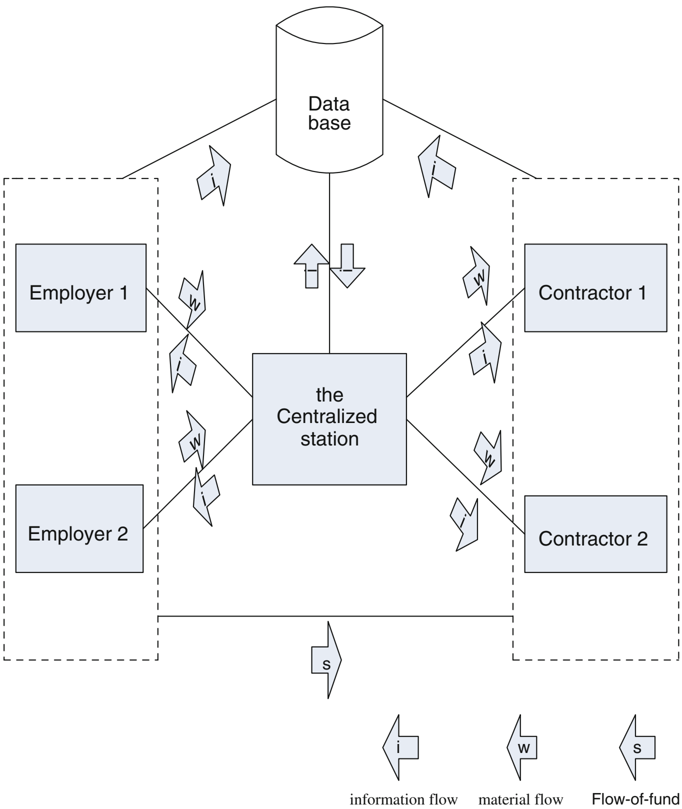

Fig. 110.1 The horizontal-intermediary virtual integration mode

110.4 Case Studies

110.4.1 Internal Resources and Environment of the Hua Ming Industrial Park

The Industrial Park, established in September 2008, is now planning area of 5.62 km^2 and will reach 20 km^2 in the future. The park has five major industrial chain clusters including aerospace components, electrical equipment and spare parts, rail transportation equipment, electronic information and advanced equipment manufacturing industry supporting services.

110.4.2 Solid Waste Outsourcing Operation Mode

The park focuses on the big industries which produce large amount of waste, carries out the work about the comprehensive utilization of solid waste and constructs the process of the industry solid waste comprehensive utilization. The recycle of scrap metal, waste packages, waste papers and waste plastics focuses on building comprehensive recycling projects of waste materials. We need to construct waste sorting, collection, transportation, disposal facilities, waste resources projects, sludge utilization and safe disposal project, promote waste composting and waste-to-energy technology and focus on building the safe disposal of hazardous waste projects like used batteries, fluorescent lamps and medical waste harmless processing (Fig. 110.2).

According to the combination of the model above, the whole process of scrap metal, waste packaging, waste paper and waste plastics outsourcing will involve a series of process such as the dismantling of waste, recycling and processing. Those processes will involve different types of companies at the same time. And the

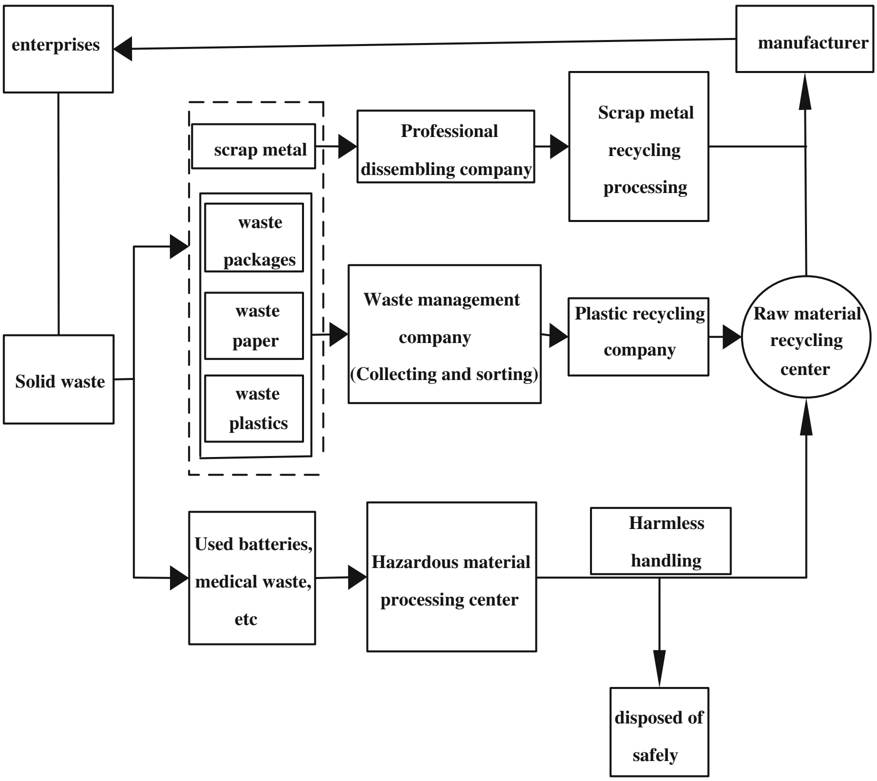

Fig. 110.2 Solid waste concentration process

outsourcing of hazardous wastes needs to be paid special attention in the process of solid waste outsourcing. Employers require careful consideration of the contractor's technical and related issues in order to avoid secondary pollution.

110.5 Measures and Recommendations

The effective operation of information technology has not only accelerated the outsourcing of the entire operating efficiency, but also has accelerated the process of ecological industrial park. By the analysis of the mode, we should pay attention to the characteristics of the mode and combine with the characteristics of the industrial parks to give better play to the advantages of this mode in the solid waste outsourcing.

110.5.1 Strengthen the Waste of Resources and Process

Under the feasible technology, the economic benefits of waste resources and the standard conditions of resource products, we master the basic technology of the use of renewable resources from a macro point of view to strengthen the management of the solid waste recycling process, considering the whole production-consumption cycle system.

110.5.2 Accelerate the Systems Process of Solid Waste Outsourcing Informatization

With the analysis of the entire information model, we need to consider the comprehensive utilization of information technology and the systematic evaluation criteria.

With the utilization of IT, we have to consider the problems of network technology, workflow management technology, and XML document standards. These technologies provide technical supports for information sharing, information and data exchange. System evaluation criteria, based on the solid waste information management system, needs to be considered mainly a series of processes such as the management of solid waste outsourcing organizational model, the main types of contractors, outsourcing management processes settings, information exchange document settings, high-tech applications and integrated information managements.

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Chapter 111
Research on the Selection of Project Management Mode for Non-Business Urban Infrastructure Construction

Xin Sun and Hong Ke

Abstract With the continuous development of urbanization, in the process of urban infrastructure construction especially the non-operational infrastructure construction, the economic loss, time delay, low efficiency of investment caused by the improper selection of project management frequently occurred. This article analyzes the major project management pattern and non-operational infrastructure construction project characteristic, then uses the qualitative analysis for primary management patterns selection, then quantitative analysis of coupled hierarchical analysis and comprehensive evaluation for final appropriate selection. This provides the theory basis, in order to save the project cost, improve the efficiency of management goals for future non-business urban infrastructure construction project management model selection.

Keywords Comprehensive evaluation · Hierarchical analysis · Non-business urban infrastructure · Project management mode

111.1 Introduction

The city infrastructures are to provide all kinds of facilities and service for economic development and proving city residents' lives, and they are public service systems designed to ensure social economic activities normal in countries or regions (Li 2009). Under the framework of socialist market economy, the civil infrastructure demand is also increasing, as urban population increases constantly. In response to the international financial crisis in 2008, the Chinese government invested RMB 4 trillion to build infrastructure projects, such as the comfortable

X. Sun (✉) · H. Ke
Management School, Tianjin University of Technology,
Tianjin, China
e-mail: sunx263@126.com

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housing project, railway, highway, airport, the rural people's livelihood construction, rural infrastructure and so on (Huang et al. 2005). Non-business city infrastructure projects belong to the public goods, they have no charge mechanism, no capital inflows generally, such as municipal roads, pipe network, green landscape construction, fire disaster prevention project, urban lighting, parks and museums, etc. These investment projects are to bear mainly by the government represented the public interest. These non-business urban infrastructure construction projects have basic characteristics of big scale (Harold 2003), long construction period and complex relationship between parties (Chen 2010). If we choose the wrong management pattern, it will cause the phenomenon of the inferior quality and low efficiency of investment generally (Luo 2004). Furthermore, these will damage the interests of both contracting parties, prevent the development of urban infrastructure construction from moving forward. In order to optimize the interests of both contracting parties, achieve the expected economic benefits, we can only select the rational project management mode. Therefore, this article is trying to choose reasonable project management model by effective methods which qualitative combined with quantitative analysis.

111.2 The Description of Non-Business Urban Infrastructure Project Management Mode

111.2.1 The Characteristics of Non-Business Urban Infrastructure Projects

Non-business urban infrastructure construction projects aim to realize social goals and environmental objectives, and provide products or services for the social public, including the social public welfare project, environmental protection and environmental pollution treatment projects, some public infrastructure projects, etc. The subject of project investment is usually the government. In addition to general construction projects' characteristics of one-time, the specific life cycle, irreversible theory, the non-business urban infrastructure project also has the following features:

1. The investment subject is single.
2. Non-business urban infrastructure construction projects have a greater risk than the average projects.
3. The implementation effect of non-business urban infrastructure construction project is difficult to evaluate.
4. Non-business urban infrastructure construction projects are more strictly than the common ones.
5. Non-business urban infrastructure construction projects have large external effects.

6. The goal of non-business urban infrastructure construction is efficiency and fairness.
7. The cost and income structure of non-business urban infrastructure are complex.

111.2.2 The Common Project Management Mode

In order to meet the characteristics and demands of modern construction project management, we must select the reasonable and proper project management pattern. The premise of the appropriate selection is firstly to understand each project management pattern. Design-Build model (hereinafter referred to as the DB mode), also is called Turn-Key-Operate in international, Design-Construction contract mode in China, it is to point to the initial phase of the project, the owner invited several qualified contractors to bid. According to the project established principle, each contractor provides preliminary design and cost estimates, and will be responsible for design and construction of the project. Design-the tender-Build model (hereinafter referred to as the DBB mode), it is one kind of the most general and early used mode in the international projects. The owner consigns an architect or consulting engineers in the early work (such as opportunity study, feasibility study, etc.), and make design after project evaluation applications. Engineering Procurement Construction mode (hereinafter referred to as the EPC mode) is to point to the later stage of project decision-making. It starts from designing, go through the tender, entrust a company to design, purchase and build on contract. In this mode, the construction company is responsible for the progress of the project, cost control, quality, safety management and completed project according to the contract. Construction project Management mode (hereinafter referred to as the CM mode), also called stage development mode or rapid rail mode. CM mode is known as owner entrust construction manager who will be in charge of the whole project management. The CM unit impacts on design activity and organize production. Product Material Control mode is called PMC for short. Contractor entrusted by the owner manages a whole project. In the area of PMC determined, the contractors make the whole process management to EPC. The owner decided to the project's objectives and strategies. Partnering mode determine the construction project common goals base on the interests of all parties construction. As shown in Table 111.1, the following six construction project management modes are introduced (Zhu 2006).

Table 111.1 The summary of the project management mode

Mode	Property	Main characteristics	
		Advantages	Faults
DB mode	New model	The owner and the contractor reduce the coordination of time and money, which helps to shorten the construction period	The owner is lack of control at design, the level of the general contractor has great influence on the quality of design
DBB mode	Early mode	Versatility, be helpful for contract management, risk management	Long cycle, the owner invest more in earlier stage, easily to cause the claim
EPC mode	Widely used, will exist for a long time	The owner has less workload of co-ordination, which be helpful for control cost	Contract value is higher, the contractor responsibility is heavy, and the risk is big, they need higher management level and richer practical experience
CM mode	New contracting way, has the advantages	Be helpful to harmonize between the reasonable design and construction, shorten the construction period	As the design and construction is at the same time, the contractor bear bigger risk
PMC mode	New model	Giving full play to the contractor project management skills, saving investment, shortening the construction period	The owner is at the low degree in construction; choosing a high level of the project management company is very important
Partnering mode	Foreign new project management mode	Construction participants signed agreement voluntary	Members of the organization trust each other, indirect investment costs more, there is no contract in the sense of law

111.3 The Selection Path of Project Management Pattern for Non-Business Urban Infrastructure Construction

111.3.1 Qualitative Research on Project Management Mode for Non-Business Urban Infrastructure

The so-called qualitative research is a kind of non-quantification, non-statistics research. Qualitative analysis is mainly to describe and interpret the social phenomenon, and is also foundation analysis before using other complex research methods. Based on the characteristics analysis about the above six kinds of project management mode, this paper give study to the concerned condition from the aspect of the owner, project management, resource allocation and the construction implementation, when we select project management mode. Through this qualitative research, it'll give the preliminary selection of non-business urban infrastructure project management model. Finally, we can get the best project management mode by further quantitative analysis based on the result of qualitative analysis.

1. The selection of Non-business urban infrastructure construction from considering owner factor

As to be the main management subject, the owner has many aspects of the defects such as the low efficiency, non-professional and so on. The construction unit is often the use unit. For concerning about their own interests, the construction unit will enlarge the scale, improve the construction standards without authorization in project construction. Owner often can't manage effectively, because they don't have sufficient construction project experience. The owner should choose a general contractor to take charge of the whole project management (Cleland and Gareis 2006).

2. The selection of Non-business urban infrastructure construction from considering project management factor

The management institutions of urban infrastructure construction project are one-time and temporarily. These temporary management institutions will disband after completing the project. Therefore, the experience of construction project is hard to accumulate. That makes low professional management level, safety and quality problems easily occur. So the owner and the contractor need to get along well in the selected project management mode. The government investment project has relationship between the people's livelihood mostly, so the management of the construction require high level of professional and technical skill to control the quality, limit time and control construction cost.

3. The selection of Non-business urban infrastructure construction from considering resource allocation factor

As project resources are limited, the efficiency of project organization presents a high demand. The resources will not get good use if the organization management is diversity in non-business government investment projects. Wasting resources will lead to the loss of national finance investment. Therefore, we need to save resources and reduce project cost considering the resources disposition in non-business government investment projects construction.

4. The selection of Non-business urban infrastructure construction from considering project implementation factor

In China, there is a system to complete investment, construction, management and use for non-business urban infrastructure construction projects. All parties in the system can communicate easily, but also have shortcomings of unknown responsibility and interest. Lack of constraint force in some non-business

Table 111.2 The final selection of project managements mode for non-business urban infrastructure construction

Mode index	DB mode	DBB mode	EPC mode	CM mode	PMC mode	Partnering mode
Owner	√	×	√	√	√	√
Project management institutions	√	×	√	√	√	×
Resource allocation	√	√	√	×	√	×
Project implementation	×	√	√	√	√	×
Summary	3	2	4	3	4	1

government project and irregularities of owners and contractors is the original root caused disorder in construction industry. So the mode which has clear responsibility is what we need (Wang 2009).

Through the above four aspects of qualitative analysis, combining with the characteristics analysis of six project management modes in the first part, this paper sums up the preliminary options, as shown in Table 111.2.

Through the above research, we finally select EPC mode and PMC mode which is the most times two project management modes. These two modes are considered to be more suitable for the government investment projects. These projects have characteristics of large scale, long term, and complex technology (Liu 2009). The second selection is DB mode or CM mode. Because the Partnering mode has no support on laws and regulations, and its cooperation subject is based on mutual trust, meanwhile it has just appear in our country without complete system. Therefore, this paper considered that the Partnering model isn't suitable for non-business urban infrastructure project.

111.3.2 Quantitative Research on Project Management Mode Selection for Non-Business Urban Infrastructure

Through the above qualitative analysis, we just get the preliminary imprecise selected results of project management mode. In some cases, the preliminary results may be only a set of some suitable project management mode, not the most optimal project management mode. Therefore, we need to make further quantitative analysis based on qualitative analysis results. The quantitative research is to establish the analytical hierarchy process (AHP) model and combine with comprehensive evaluation of the calculation of the score, then we can choose the most suitable project management mode which the score is highest (Qi et al. 2010).

(1) Build hierarchical structure model

Multi-layer hierarchical analysis model is based on the characteristic of the non-business urban infrastructure project management mode, as is shown in Fig. 111.1.

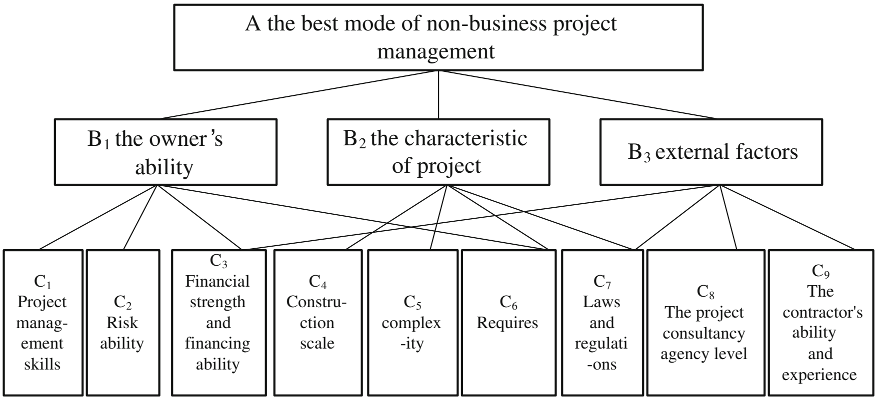

Fig. 111.1 The hierarchical structure model

(2) Calculation of the Multi-layer hierarchical structure mode

1. Establishing judgment matrix. First, we establish a judgment matrix through the analytical hierarchy process method(AHP), then compare the two indexes at the same level which is directly linked with the above one (Wang and Guan 2004). We can make sure the index's importance degree by using the aid of factors assignment table (Table 111.3), then take an average of experts score to get the most suitable mode.
2. Single weight and Consistency inspection using the Rad method.

$$M_i = \prod_{j=1}^{n} b_{ij} \; (\mathrm{i} = 1, 2, \ldots, \mathrm{n}) \tag{111.1}$$

$$\overline{W_i} = \sqrt[n]{M_i} \; (\mathrm{i} = 1, 2, \ldots, \mathrm{n}) \tag{111.2}$$

$$W_i = \frac{\overline{W_i}}{\sum_{i=1}^{n} \overline{W_j}} \; (\mathrm{i} = 1, 2, \ldots, \mathrm{n}) \tag{111.3}$$

Table 111.3 Factor assignment table

Date	Meaning
1	The same influence degree between C_i and C_j
3	Ci has slightly stronger influence than Cj
5	Ci has stronger influence than Cj
7	Ci has significantly stronger influence than Cj
9	Ci has absolutely stronger influence than Cj
2, 4, 6, 8	Median level of the above two judgment
Reciprocal	Contrary mean

Then W = (W1, W2,…, Wn) is Feature vector T, the biggest characteristic root is $\lambda_{\max}$:

$$\lambda_{\max} = \frac{1}{n}\sum_{i=1}^{m}\frac{(BW)_i}{W_i} \tag{111.4}$$

$$CI = \frac{\lambda_{\max} - n}{n - 1} \tag{111.5}$$

Consistency index CR = CI/RI, but CR ≦ 0.10, the judgment matrix is satisfied with the consistency, otherwise, we need to adjust it. According to the above formula calculation, comparing 0.1 with CR, we can judge matrix whether meet the consistency inspection or not (Turner and Simister 2005).

(3) The total weight and consistency inspection

According to conclusion obtained through the analytical hierarchy process (AHP) which is the most important index, and which is the next. Using to design the evaluation index score table, we investigate the professor majored in project management and experts with the score table (Monzon). We use the evaluation index score table for n a number, then take an average to obtains the average scores of index of each project model.

The calculation of comprehensive evaluation score in the evaluation index scoring table is based on the analytic hierarchy process (AHP) and experts scoring. According to the weight of each index obtained form AHP and each index score given by experts, we seek the comprehensive evaluation score. The model corresponding with the highest score is the proper patterns which are looking for. The score of each index multiply its weight equal to the comprehensive score of each model (Ji and Shi 2010).

Through the calculation of the index, we can get the index score of construction project management mode. By sorting scores, the model corresponding with the highest score is the most suitable patterns for the urban infrastructure construction project management mode through quantitative method (Wu et al. 2009). Non-business project management using the selected model will maximize the benefit between owner and the contractor, promote the further development of the urbanization, and meet the needs of the people's production and life.

111.4 Conclusion

Under the framework of socialist market economy, the urban population increase constantly, and the demand for urban infrastructure are also increasing. In this case, the successful urban infrastructure construction is very important. The success of the construction and the maximize interests of both parties depends on selecting appropriate project management mode. This article analysis the characteristics of six kinds of project management pattern, and make further qualitative research from four aspects to provide initial selection for urban infrastructure construction project management mode. Using quantitative analysis which includes AHP method and comprehensive evaluation, we can find the most appropriate project management mode for the non-business urban infrastructure construction. The qualitative combining with quantitative analysis method can make the projects analysis more comprehensively and objectively, and the final selected mode can improve the performance of project management, save the project cost, reduce the loss of project venture.

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Chapter 112
Study on the Dynamic Game Problem of Indemnificatory Apartment Construction Based on System Dynamics

Yong Li, Ge Huang, Ya-qin Qu and Hui Xiong

Abstract This paper analyzes a dynamic game between the central and local governments in the construction of indemnificatory apartment. Some simulation models are established under system dynamics. Granted the game payoff, it is found that with the central government's investment for the construction of indemnificatory apartment increased, if the incentive system and punishment measures of the central government are not clear, local governments will continue to reduce the amount of investment and tend not to invest. Finally, the paper presents some political suggestions on the central and local governments.

Keywords Game playing · Indemnificatory apartment construction · System dynamics · The central and local governments

112.1 Introduction

The construction of indemnificatory apartment is an important livelihood issue, directly related to social justice and harmony. In recent years, the central government brought forward a series of policies to solve the problem of housing security for residents. However, due to the game generated between the central and local

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Y. Li (✉)
Department of Business Administration, Changsha University,
Changsha, China
e-mail: hg947821869@126.com

Y. Li · G. Huang · Y. Qu · H. Xiong
School of Public Administration, Xiangtan University, Xiangtan, China

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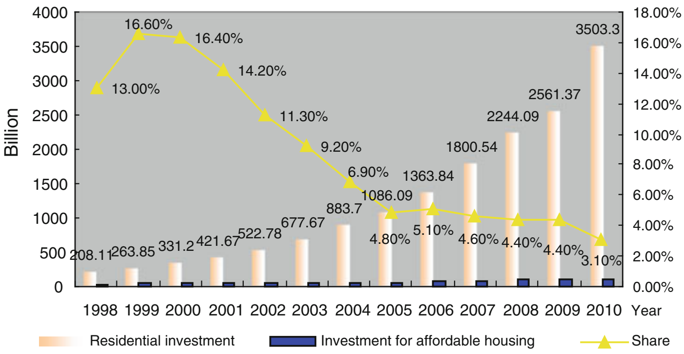


Fig. 112.1 The amount of investment for residence and affordable housing from 1998 to 2010

governments for their own interests, the policy enforcement of indemnificatory apartment construction greatly reduced (Cai 2009).From the historical data (Fig. 112.1), the residential investment of the central government increased to 3.5033 trillion in 2010 from 208.11 billion in 1998, with an annual growth rate of 26.53 % (Wang and Ding 2011). And the investment for the main body of indemnificatory apartment construction—affordable housing increased from 27.0543 billion in 1998 to 108.6023 billion in 2010, with an average annual growth rate of 12.28 %. However, the share of indemnificatory apartment in residential investment only increased to 16.60 % in 1999 from 13.00 % in 1998, then decreased continually until 3.10 % in 2010 with an annual growth rate of -11.26 %. This result has seriously deviated from the target of improving the proportion of the investment for affordable housing in residential investment. If this trend continues, it will be difficult to meet the "12th five-Year plan" target. Therefore, study on the game problem of indemnificatory apartment construction will contribute to find ways to get rid of the game plight and accelerate the pace of construction. So far, there has been little research in this area in China, and most of which considered that the game is a static game of complete information (Cai 2009; Sun et al. 2003), that is, assuming that the players are known to their respective strategies, the central and local governments will make choices referencing to the opponent' strategy. However, the reality is not the case, considering the financial and economic interests as well as external uncertainties, the central and local governments are often difficult to precisely know each other's strategy, which means, the game between them is a dynamic game of incomplete information (Sun et al. 2003). In this paper, a dynamic game of incomplete information between the central and local governments is reproduced with systems dynamics and simulation. Based on deeply analysis on causes of the game plight, this article put forward some suggestions against it.

112.2 Analysis

On the starting of the construction of indemnificatory apartment, the central and local governments have their own interests to consider and strategies to select (Zhang 2009). When a local government is playing game with the central government, not only their own interests and the central government's options but also the strategic choice of other local governments will be considered; besides the local governments' strategies, the central government will also consider its own financial situation (Alós-Ferrer and Ania 2005).

112.2.1 The Interests of Local Governments to Consider and Strategies to Select

To the local governments, economy development is the first target of their self-development, directly manifested on GDP growth and the urbanization process. In order to develop faster and get more economic benefits, many local governments are dependent on the "land finance". Although the construction of indemnificatory apartment can improve people's livelihood and ease the housing contradictions, it will consume huge manpower, material and financial resources, and naturally affect the performance and image of the government-led, allowing local governments do not want to put a lot of land resources for large-scale construction of indemnificatory apartment. When making choice, local governments will also take other local governments' decision into account, so it cannot be ruled out that they have luck and a herd mentality. Because of competition between the various local governments, most of them believe that the construction of indemnificatory apartment is a threat to local real estate market demands and will lead to outflows of investment. Consequently, other local governments will get more investment. In this way, local governments will think that they may put themselves on the defensive. Thus, they will not take a proactive approach in the construction of indemnificatory apartment. Secondly, to avoid the risk of punishment from the central government, local governments will not adopt non-investment in the construction; at the same time, they are not willing to invest completely, so they want to get more subsidies from the central government to reduce their own investment as much as possible without punishment.

Therefore, local governments can't just choose to invest or not. Their choices must be a mixture of them, according to the central government's funding status and punishment. Local governments will probably invest if the central government allocates funds a lot and takes severe punishment; otherwise, the local government will be less likely to invest.

112.2.2 The Interests of the Central Government to Consider and Strategies to Select

To the central government, the housing justice of national people and the stability of society are their greatest concern. The central government thinks that indemnificatory apartment construction is an effective means to solve the housing problem and the fundamental way to enhance the housing level of the whole country and to get overall effects (Tan and Lou 2012). The central government regards the whole country as a market from a global perspective, so how investment flows in market will not be considered. Although the central government is actively promoting the construction of indemnificatory apartment and provides some related policies, institutional and financial support, the finance crisis may arise without enough funds. Coupled with various uncertainties, appropriations for the local governments for the construction will be not fully guaranteed.

Therefore, local governments can't just choose to invest or not. Their choices must be a mixture of them, according to specific financial situation of the central government and social contradiction. The better finances of the central government and the severer housing contradiction is, the more funds will be allocated for local governments in time and the central governments will be more likely to invest; otherwise, the central government will be less likely to invest.

112.3 Modeling and Simulation

According to the analysis above, it can be concluded that the game between the central and local governments is more in line with the characteristics of a dynamic game. The system dynamics method is a combination of qualitative and quantitative, which can effectively solve the dynamic game problem from the overall situation (Wang 2009). Therefore, this method is used in this paper to model and emulate game problem of indemnificatory apartment construction.

112.3.1 Description of the Game Model Between Central and Local Governments

As game players, central and local governments' strategies include two aspects: (1) invest; (2) not invest. In the condition that the central government choose to invest, we assume that local governments can get a_1 unit return if invest, c_1 unit return if not invest; in the condition that the central government chooses not to invest, we assume that local governments can get b_1 unit return if invest, d_1 unit return if not invest. In the condition that local governments choose to invest, we assume that the central government can get a_2 unit return if invest, b_2 unit return if

Table 112.1 The game pay off matrix of central and local governments

The central government	Invest	Not invest
The local government Invest	(a_1, a_2)	(b_1, b_2)
Not invest	(c_1, c_2)	(d_1, d_2)

not invest; in the condition that local governments choose not to invest, we assume that the central government can get c_2 unit return if invest, d_2 unit return if not invest.

To understand this, the game description with matrix is presented in Table 112.1.

With analyses from the perspective of income, if both the central and local governments do not invest, both sides' gains are equal to 0. So, if a game player already know that his opponent choose not to invest and he choose to invest, his gain will be higher than the situation that he choose not to invest; if a game player already know opponent choose to invest and he choose not to invest, his gain will be higher than the situation that he choose to invest because of the cost transference. Therefore, when the central government chooses to invest, the optimal strategy for local governments is not to invest, namely $b_1 > d_1$; when the central government chooses not to invest, the optimal strategy for local government investment is to invest, namely $b_2 > a_2$. Similarly, when local governments chooses to invest, the optimal strategy for central government is not to invest, namely $b_2 > a_2$; when local governments chooses not to invest, the optimal strategy for central government investment is to invest, namely $c_2 > d_2$.

Considering the reality strategies of the central and local governments, we assume that the mixed strategy of the central government is $S_g = (I_1, 1 - I_1)$. In it, I_1 is the probability of central government choosing to invest. And we assume that the mixed strategy of local governments is $S_e = (I_2, 1 - I_2)$. In it, I_2 is the probability of local governments choosing to invest.

Assuming that the expected revenue function of the central government is $E_g(S_g, S_e)$, the expected revenue function of local governments is $E_e(S_g, S_e)$, we get:

$$E_g(S_g, S_e) = I_1[I_2 a_2 + (1 - I_2)c_2] + (1 - I_1)[I_2 b_2 + (1 - I_2)d_2] \tag{112.1}$$

$$E_e(S_g, S_e) = I_2[I_1 a_1 + (1 - I_1)b_1] + (1 - I_2)[I_1 c_1 + (1 - I_1)d_1] \tag{112.2}$$

112.3.2 The Construction of the Game Model Between the Central and Local Governments

Granted the game benefits of the central and local governments, the game model between the central and local governments for indemnificatory apartment construction is established with Vensim under the conditions that the incentives and punitive measures of the central government is not clear (Cai et al. 2009) (Fig. 112.2).

Among them, external constants of the model are described in Table 112.2.

And, external variables of the model are described in Table 112.3.

The main formulas of the model are as follows:

If the expectation of the central government choosing to invest is E_{11}, then,

$$E_{11} = I_2 a_2 + (1 - I_2) c_2 \tag{112.3}$$

If the expectation of the central government choosing not to invest is E_{12}, then,

$$E_{12} = I_2 b_2 + (1 - I_2) d_2 \tag{112.4}$$

If the expectation of local governments choosing to invest is E_{21}, then,

$$E_{21} = I_1 a_1 + (1 - I_1) b_1 \tag{112.5}$$

If the expectations of local governments choosing not to invest is E_{22}, then,

$$E_{22} = I_1 c_1 + (1 - I_1) d_1 \tag{112.6}$$

Based on the replicator dynamics in cultural evolution, the game player with lower income will learn the opponent's strategy (Levine 2007; Qiu and Jin 2006).

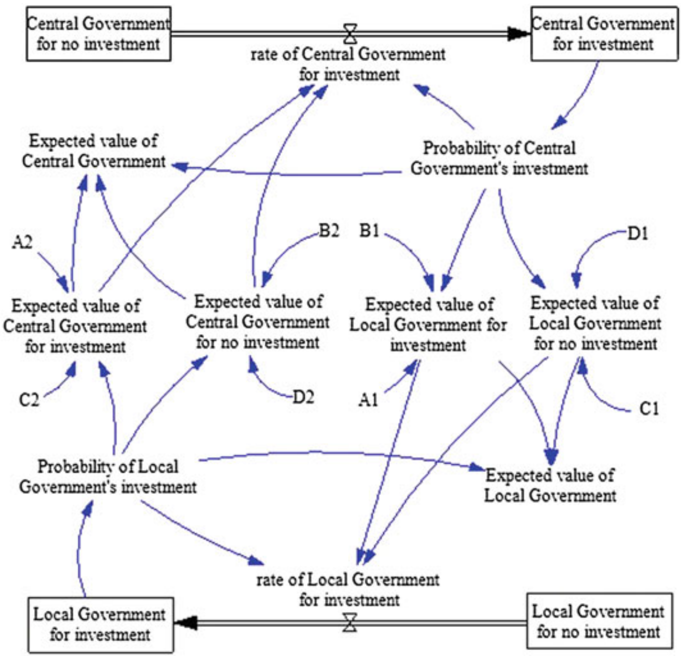


Fig. 112.2 System dynamics game model between the central and local governments

Table 112.2 External constants of the game model

Symbol	External constants	Values
a_1	A1: (local government's income for investment with central government for investment)	5
b_1	B1: (local government's income for investment with central government for no investment)	5
c_1	C1: (local government's income for no investment with central government for investment)	10
d_1	D1: (local government's income for no investment with central government for no investment)	0
a_2	A2: (central government's income for investment with local government for investment)	10
b_2	B2: (central government's income for no investment with local government for investment)	15
c_2	C2: (central government's income for investment with local government for no investment)	10
d_2	D2: (central government's income for no investment with local government for no investment)	0

Table 112.3 External variables of the game model

Symbol	External variables	Description
$E_g\left(S_g \cdot S_e\right)$	Expected value of central government	Function
$E_e\left(S_g \cdot S_e\right)$	Expected value of local government	Function
I_1	Probability of central government's investment	Variable
I_2	Probability of local government's investment	Variable
E_{11}	Expected value of central government for investment	Function
E_{12}	Expected value of central government for no investment	Function
E_{21}	Expected value of local government for investment	Function
E_{22}	Expected value of local government for no investment	Function
$\frac{dI_1}{dt}$	Rate of central government for investment	Function
$\frac{dI_2}{dt}$	Rate of local government for investment	Function

The flow rate of central government's investment –the dynamic rate of change of the ratio of the central government' investment is determined as $\frac{dI_1}{dt}$, then,

$$\frac{dI_1}{dt} = I_1(1 - I_1)(E_{11} - E_{12}) \tag{112.7}$$

The flow rate of local governments' investment—the dynamic rate of change of the ratio of local governments' investment is determined as $\frac{dI_2}{dt}$, then,

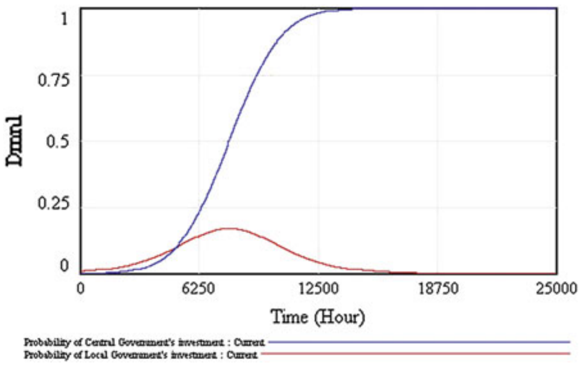
$$\frac{dI_2}{dt} = I_2(1 - I_2)(E_{21} - E_{22}) \tag{112.8}$$

112.3.3 The Simulation of the Game Model Between the Central and Local Governments

Assuming that the start time of simulation is zero, the end time is 25,000 h and the simulation step length is one hour, so INITIAL TIME = 0, FINAL TIME = 25,000 (Hour), TIME STEP = 1. Through the simulation (Fig. 112.3), the following conclusions can be drawn. Local governments will respond to the policies of the central government only for a short time. With the increase of investment from the central government, local governments will gradually reduce their investment. Finally, local governments tend not to invest; the probability of choosing to invest is 0. Consequently, the central government will be put into malign situation, in which the probability of investment equals to 1.

During the simulation, we also found in Fig. 112.4. if the central government chooses to invest while local governments choose not to invest, we'll obtain a Nash equilibrium solution of the central and local governments. Before they reach a Nash equilibrium solution, you can see that the expected revenue of the central and local governments almost constitute a set of parallel lines and the local governments' revenue is always less than the central government's. Until the Nash equilibrium is reached, the profits of both sides are both equal to 10. One conclusion from all this is that in the indemnificatory apartment construction, local governments are generally in a negative state with a "non-cooperative game" (Başar and Olsder 1999) attitude. If the central government can't allocate funds at the right time and with the right quality, and cannot develop effective incentives and punitive measures, the central government will get into an extremely adverse dilemma. This also verified why the central government continuously rise the investment of affordable housing, but the share of it in residence decrease gradually with an annual growth rate of −11.26 %.

Fig. 112.3 Probability of investment of the central and local governments



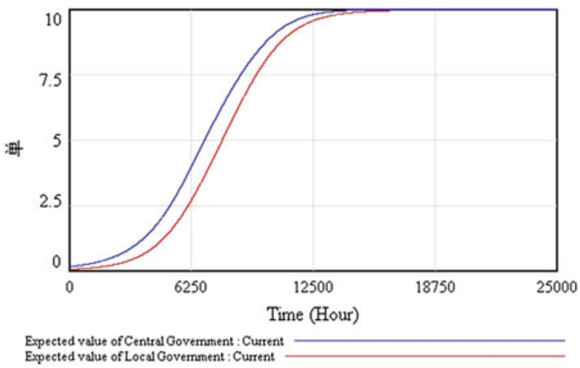


Fig. 112.4 Expected revenue of the central and local governments

112.4 Suggestions

We can see from the analysis above, if the central government doesn't establish effective incentives and punitive measures, local governments will not carry out indemnificatory apartment construction actively. If the trend continues, the construction policies will not be implemented effectively and social justice and harmony will be blocked. If this happened, the central government will certainly not sit back. Therefore, in order to better promote the construction of indemnificatory apartment, we offer some suggestions on the basis of the study.

112.4.1 Suggestions for Local Governments

As the executor for maintenance of stability, promoting the development of economy and management of public affairs, only by giving up the "non-cooperative game" attitude and cooperating with the central government (Xu and Wu 2011; Aguirregabiria 2011) can local governments achieve long-term regional economy development interests; only by adopting a positive attitude, can they avoid the risk of punishment by the central government and establish a responsible image in the public mind, then, truly promote social equity and harmony. Therefore, local governments need to pay attention to the following things:

1. *Practicing the scientific outlook on development*

The local government should understand the concept of a scientific outlook on development properly and balance development and justice. In the course of developing economy, social equity should also be considered. Social equity issues affect the social stability directly. If social stability is not handled properly, development will lose the deserved significance. Therefore, local governments should regard the development of indemnificatory apartment as a social responsibility and promote its construction actively.

2. *Increasing public awareness of service*

In the game of the central and local governments, if local governments adhere to carry out the central policies as "economic man" status who seeks to maximize their own interests, they will undoubtedly make irrational decisions, pursuit GDP growth excessively and ignore the interests of vulnerable groups in society. Thus, social conflicts will be brought up and social justice will be impeded. Therefore, to correct these problems, local governments must enhance public awareness of service to protect housing benefits of low-income families. Besides, they should adjust public service ideas and strategies, so that social harmony will be achieved and interests of the citizens will be maximized.

3. *Implementing the central policy*

In the marketization, the decentralization of the central government not only has stimulated the enthusiasm of local governments to develop the regional economy, making local government's independent economic stakeholders, but also weakened supervision of local governments from the central government. As a result, only when the central policies and the interests of local governments reach consensus, will local governments executed central policies well. Once their own interests clashed with central policies, local governments will hold the attitude of "non-cooperative game". This not only does not favor long-term development of the place, but also will reduce the public services quality of governments and provoke a public backlash. Therefore, local governments should convert their role from "economic man" to a public service. They should truly understand and accurately grasp the essence and value orientation of protecting the rights of citizens, enhance the initiative and consciousness of policies execution, meet the needs of the public, raise living standards and ultimately realize the transition from the economic interests to social justice.

112.4.2 Suggestions for the Central Government

The central government should avoid falling into a plight of completely investing and improve the enthusiasm local governments for carrying out the construction of indemnificatory apartment. The following points should be paid attention to:

1. *Making clear responsibilities and obligations of the central government*

The central government plays the role of planners and supervisors in the indemnificatory apartment construction while local governments work as the implementers. The responsibilities of both sides should be clear. Once problems occur, the central and local governments should shoulder their own part of the problems. In this way, the "conformity" and "risk-taking behavior" in the game can be avoided.

2. *Adjusting pattern of interests with the local governments appropriately*

Based on rational assumption, the central government is the representative of public interests of the entire society, seeking to maximize the interests of the community, while local governments are independent stakeholders, indulging to maximize local interests. If interests between the two parts cannot be effectively integrated, the central government will fell into in the plight of completely investment and the construction of indemnificatory apartment will be severely restricted. Therefore, the central government must integrate with the interests of local governments effectively, protect the revenue of them, reduce the reliance on the "land finance" of them and achieve a balance of interests between the two sides.

3. *Establishing both incentives and punish mechanisms for local governments*

In China, the power relation which can be seen from the progressive debugging mechanism—the central government making policies while local governments carrying out them—is a unidirectional dynamic equilibrium rather than a bidirectional one. With excessive authority and financial resources centralized by the central government, local governments are in executive strata which put them in weak position. In addition, local governments focused only on their own interests and did not fully assume the responsibilities for implementation of housing security, causing "non-cooperative game" phenomenon between central and local governments. Therefore, it is necessary for the central government to establish both incentives and punish mechanisms for local governments, and guide them to take the responsibility of the construction of indemnificatory apartment. For incentives and punish mechanisms, the central government should establish a sound scientific evaluation system, taking into account the social and economic benefits. And the central government should emphases society benefit index and integrate the indemnificatory apartment construction into the management and political performance-assessment of public affairs of local governments. Besides, the well-performing and crowd-pleasing local governments' officials should be promoted or rewarded and for the governments not in place should be criticized and take steps to rectify.

112.5 Conclusion

In this paper, based on the analysis of the main part in the game in the construction of indemnificatory apartment—the interests and strategies selected by central and local governments, system dynamics is used to model and emulate the game. Under a hypothesis that the profits of central and local governments in the game are known, we find that if the central government does not have clear incentive and punitive measures, as the investment of the central government increased, local governments will reduce their investment and tend not to invest. On the basis of modeling and simulation, this paper also put forward political suggestions for both sides. But the study on the game problem of construction of indemnificatory apartment in this article is limited, because the demands in housing market fluctuating, so as their income. Thus there still have a certain gap between the assumptions and the reality and that is where we're planning to take this research next.

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Chapter 113
The Design and Implementation of Petrochemical Enterprise's Safety Management Informatization System Based on WEB

Yun-juan Liu, Wei-tao Liu and Jian-jun Shen

Abstract In order to realize the systematization, informatization and high efficient of the petrochemical enterprise's safety management, with the safety management principle as the theoretical basis and using the ASP.Net technology, this article researched and analyzed the system design of the petrochemical enterprise's safety management informatization system and the function of each module, realized the information platform function of the petrochemical enterprise's safety management informatization by using Java web technology and My SQL database programming technology.

Keywords ASP.NET technology · Informatization system · Petrochemical enterprise · Safety management

113.1 Introduction

With the oil production and storage capacity increasing, the petrochemical enterprise's production process and production equipment is becoming complex, the risk of the production activities and the impact on the surrounding environment is increasing. Safety production is both the basic guarantee of the staffs' life and health and a powerful guarantee of enterprise's good production efficiency

Y. Liu (✉) · W. Liu · J. Shen
Resources and Environmental Engineering Institute,
Shandong University of Science and Technology, Qingdao, China
e-mail: liuyunjuan123@163.com

W. Liu
e-mail: wtliu@sdust.edu.cn

J. Shen
e-mail: shenjianjun11987@163.com

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(Cao 2006), but more is the basic premise to achieve production and sustainable development. The petrochemical enterprise safety information management makes multipurpose use of all kinds of information resources of safety in production, provides technical support and information services for the enterprise's safety management decision, and then reaches the ultimate aim of hazard cleanup, accident prevention, boost production and security benefits. The development of security management information system is an important direction of enterprise's safety management in the future.

113.2 Analysis of Safety Management Information System Applied Theory and Realization Technique

113.2.1 Analysis of Applied Theory

The safety management information system is essentially a management information system used in the safety management fields (Chen 2007), based on safety management principle. The management is a series of activities to take effective means and methods to plan, organize, command, coordinate and control refer to people, things, time and information (Liu and Li 2009). The safety management is a process to realize safe production by organizing and using manpower, materiel and financial resources etc. all kinds of resources (Tian and Guoxun 2009).

The system is an organic integrity which has a specific function, constituted by a number of interactional and interdependent parts (Zhang 2002). And the component part of the integral is called subsystem. The safety management information system is constituted by multiple subsystems and forms an integrated man–machine system. The principle of system is to use the system theory to analyze management systematically, for the purpose of optimizing scientific management. The system theory is a general theory which puts the object as a system for research. System analysis means taking measures to make sure each part of the system and their interrelation to make the system to reach optimization (Shan et al. 2004).

113.2.2 Realization Technique

The exploitation of the petrochemical enterprise's safety management information platform needs to be backed by the advanced technology. ASP.NET is a unified Web application platform which provides the necessary service to build and deploy enterprise Web applications. ASP.NET Provides new programming model and base structure for safer, stronger upgradability and more stable application program which can face any browser or equipment (Cui 2008). ASP.NET is a part of Microsoft.NET Framework, and a kind of computing environment which can simplify the application development in the Internet of high distribution .NET Framework contains the common language runtime, and it provides different kinds of core services, such as memory management, thread management and safety code. It also includes the .NET Framework class library, and it is a comprehensive, object oriented set which is used by the developers to create application (Shixuan 2002).

113.3 Design of the Petrochemical Enterprise's Safety Management Information System

113.3.1 Significance of Information System's Construction

With the increase of oil demand and the development of petrochemical industry in society, the needs of the enterprise to safety management informatization become more and more urgent. When the knowledge of people to safety increase and the level of science and technology improve continuously, the enterprise's safety management level is gradually evolving from lower to higher, single to systematic, traditional management mode to informationize management tool (Wang 2007). The safety management is in deepening stage in the world scope and the function and effect of safety management are strengthening at present. The petrochemical enterprise is provided with the characteristic of multi-people, big span, long production line and high risk. The responsibility of safety management is significant and plays a more and more important role to ensure the safety in production of the enterprise. Petrochemical enterprise's safety management involves wide range, the management level of normalization, standardization and informatization is relatively low. It hasn't reached the comprehensive utilization of information and is short of a unified platform to provide for safety information transfer, exchange, share specially.

In addition, in the original safety management system, the safety information obtained by the security sector of enterprise can't penetrate the station. With the deepening reform of petrochemical enterprise, the requirements of the enterprise to know the factory stand security dynamic is more urgent and the original safety management information transmission modes can't satisfy enterprise's needs. Therefore, the establishment of normative petrochemical enterprise's safety management informatization system can blend the enterprise's safety concept, safety information and management measures into production preferably to realize enterprise's safety management resources sharing and real time monitoring to raise the level of the enterprise's safety management roundly.

113.3.2 Analysis of System Function Demand

The construction of petrochemical enterprise's safety management informatization system is not only an important mean for the enterprise's daily safety management and accident prevention, rescue and treatment etc., but also an important way to improve the enterprise's management level and efficiency in safety production, control management risk and reduce safety accident probability. The information system is service for the information construction's goal and requirements. Take the integrative query service as an example (Table 113.1) to sum up the function needs of petrochemical enterprise information system in integrative query service, supervisory service, information service and so on.

113.3.3 Principles of System Design

The design objective of safety management information system is to make full use of petrochemical enterprise's advanced computer network system, construct the enterprise's internal automation safety management information platform, so as to realize the enterprise's office automation, information resourcing, conveying networking and decision-making scientifically. In order to make the system can widely use, people should abide by the following basic principles in the process of system design (Wang and Zhu 2004):

1. Simple and practical principles: The system only guarantee simple, practical, and conform to the requirements of enterprise's management can play its role.
2. Safe reliability principles: The nature of enterprise decides that the enterprise's network and office system must ensure safe and reliable, use a variety of safety technology and measures to guarantee the system's information security and long-term, stable and reliable operation.

Table 113.1 Functional needs analysis of petrochemical enterprise's safety management information system

Need category	Definite content
Integrative query service	The inquiry of the enterprise's safety operation rules and regulations etc.
	The inquiry of the enterprise's security events and accident treatment etc.
	The inquiry of the enterprise's safety management measures
	The inquiry of personal information and safety training situation
	The inquiry of notice, announcement etc.
	The inquiry of enterprise's major hazard and processing measures etc.

3. Scalability principles: With the development of the enterprise, the expansion of the safety management information system is inevitable, so the feasibility of network expansion in the future should be fully considered during system design process.

113.3.4 System Framework and Function Module Analysis

This text designed the overall framework according to the function needs of the system. The system is constituted by seven modules including daily safety management, hazards and hidden danger of accident management, accident statistics management, safety education and training, occupational health management, security database management and accident emergency management (Fig. 113.1), and each module includes several sub modules.

Take the daily safety management module as an example to analyze function modules of the system. The daily safety management subsystem includes five modules shown in Fig. 113.2. Among them, the announcement of safety information module mainly provides various safety information announcement and management in petrochemical enterprise's daily safety work, mainly including safety and accident information, bulletin reports and other news related to safety management. The safety education and training module mainly aims at the

Fig. 113.1 Design of system framework

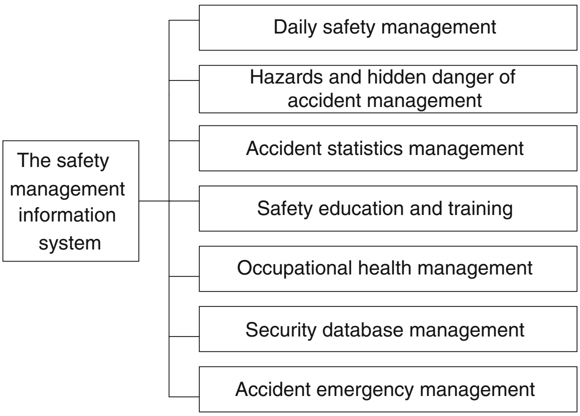
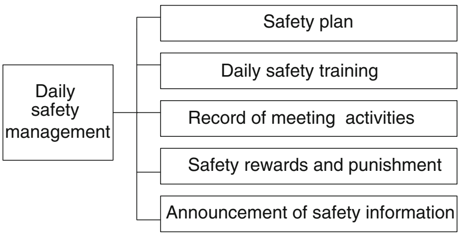


Fig. 113.2 Function modules of daily safety management



management of the worker s' training files, including new staff level 3 security training, special operation training, and other training forensics, etc.

113.3.5 Security Design of the System

The users' rights management is an indispensable part of the system construction and requirement of backstage maintenance. As the system supports multi-user online access, in order to ensure the security of the system, the designers found the system security model and set the rights of users. As shown in Figs. 113.3 and 113.4, different levels of users have different rights. Such authority filter mechanism brings a lot of flexibility to system and also makes the information management services more safety and efficiency.

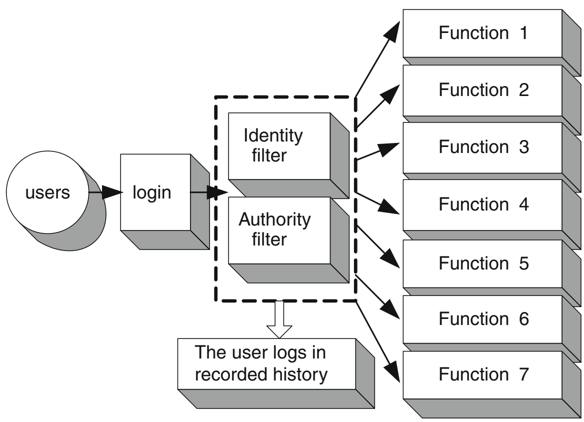
113.4 Development and Application of Safety Management Information Platform Based on ASP.NET

113.4.1 Development of Information Platform

ASP.NET is a unified Web development platform which is compiled and based on .NET. It can use any language compatible with .NET to create application, including Visual Basic.NET, C# and JScript.NET, etc. (Shang 2004).

On the basis of the B/S structure mode, the system development chooses Java as a programming language and takes MYSQL as the background database system, realizing interactive operation of webpage and background database by using Java web technology, setting up the dual connection between the client and Web server to gear up the realization of system functions (Gong 2000).

Fig. 113.3 System security model



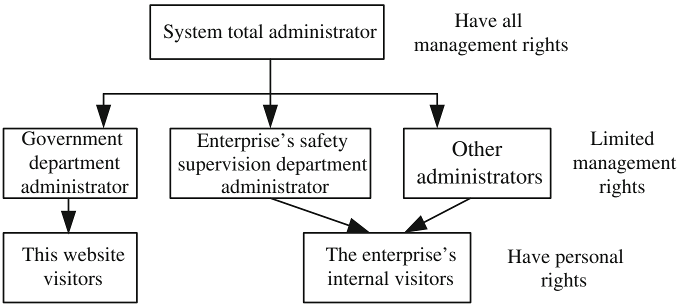


Fig. 113.4 System management rights

To carry on Java web application development, it needs to configurate the running and development environment. By comparison, this system chooses the Tomcat5.5 environment to develop and debug. As the Java used in Java web need to be compiled before deployment, so it need to use JDK1.5. After installation of JDK, start Tomcat5.5 installation program. Using the account number set up to log on to the Tomcat background management environment, which can publish web programs or create other web resources (Robinson and Nagel 2005; Zhang 2006; Liang and Zhang 2007).

113.4.2 Application of Information Platform

After running the start command of database and management system, the system will be activated to the landing interface automatically. After landing according to the operation authority, the system can be used normally.

The system makes different reaction based on users' rights. Users enter into the related scope management page through the identity filter and then carry through the specific operation. The home page of system set six functional menus and realized the specific functions of the system in daily safety management, hazards and hidden danger of accident management, accident statistics management, safety education and training, occupational health management, security database management and accident emergency management.

The petrochemical enterprise's safety management informationization construction sets up the bridge of enterprise resources sharing and information exchange. The network structure of petrochemical enterprise's safety management informationization system is shown in Fig. 113.5. It makes full use of the enterprise's network resources, not only breaks through time, space and regional limits in safety management way but also a change of management concept. The development and application of safety management information platform changed the content and way of information spreading and presents the new situation in management way.

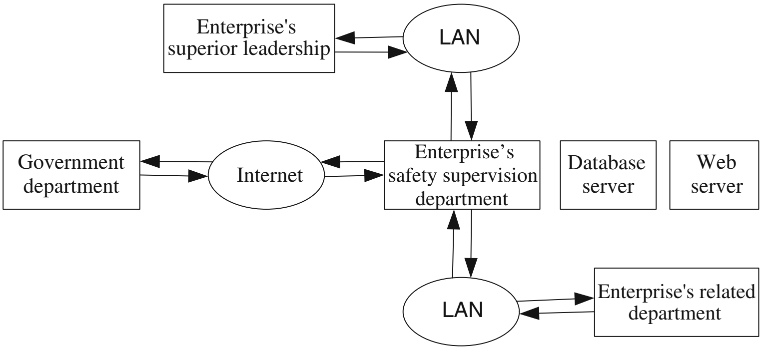


Fig. 113.5 Network structure map of security management information system

113.5 Conclusion

The safety management informationization system is the bridge for petrochemical enterprise to realize the resource sharing and information exchange. In order to facilitate the staff at all levels to collect, dispose, share and exchange safety management information, improve the efficiency of security management, this text designs and realizes petrochemical enterprise's safety management informationization system.

1. Directing at situation of petrochemical enterprise's safety management, according to the significance of safety management information system construction and analysis of function needs of safety management informationization system, this text put forward to the reasonable safety management information system modules and carried on the detailed analysis about each module function at the same time.
2. This text designed the system safety. It established the system security model, made permission settings for users of the system which set up corresponding landing and access rights to different users, ensure the system's security and secrecy.
3. Based on B/S structure mode, mainly using Java and MYSQL technology, this system established the petrochemical enterprise's safety management informationization platform, not only made full use of the enterprise's network resources, but also facilitated safety management resources sharing and information exchange.

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Chapter 114
The Relationship Studies of Commercial Banks Customer Service Systems Customer Perceived Value, Customer Satisfaction and Customer Loyalty

Ting Lei and Cunlin Li

Abstract In this rapid development of financial markets, the commercial banks have established their own customer service system in order to meet diverse customer needs, because the customer satisfaction of customer service system directly affects the customers' future behavioral intentions. Based on the domestic and foreign scholars research on customer satisfaction and customer loyalty, this paper try to build the model which suitable for measuring our country's commercial banks customer satisfaction of customer service system; This article through field investigation and network survey and uses the factor analysis, correlation coefficient and multiple regression method to further study the relationship between the customers satisfaction of commercial banks and customer loyalty, which reflect the current development of China's commercial banks customer service system.

Keywords Commercial bank customer service system · Customer perceived value · Customer satisfaction · Customer loyalty

114.1 Introduction

With the rapid development of financial markets, the provision of financial services is no longer by the state-controlled joint-stock banks, more and more private commercial banks and foreign banks have gradually entered China's financial industry which increase fierce competition. At the same time the growth of high-grade families in the domestic, the financial needs of the public increasingly diverse, many people sought the risk, value-added financial products which make

T. Lei (✉) · C. Li
School of Management, Beifang University of Nationalities,
Yinchuan, Ningxia, China
e-mail: yuxinwh_030@126.com

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the original deposit banks decreased attractive. Faced with this trend, the operation of the customer service system and the service effectiveness can direct impact on the future development of commercial banks. Through field investigation and network survey two kinds of method, This paper study the relationship between the customer perceived value, customer satisfaction and the customer loyalty of commercial banks customer service system which can provide a theoretical guidance to the future development of commercial banks.

114.2 Model Constructs

Foreign scholars began to study the customer satisfaction in the 1970s. Swan and Olshavsky and Miller (1972) scholars study found that the customer who have lower expectations for the product will arrive at a higher quality assessment compared with those who have high expectations and disappointment experienced when they face of the same product quality (Olshavsky and Miller 1972). John studied the speed of customer service response will affect customer satisfaction (Reynierse and Harker 1992).Wayne et al. (1994) and other scholars believe that the benefits to the bank by virtue of the customer reputation and integrity (Wayne et al. 1994). Nicholls et al. (1995) study found that customer waiting time, the business processing time, the staff's knowledge level, attention, the accuracy of service, the attitude and other factors will affect the bank's customer satisfaction (Nicholls et al. 1995). Johnston and Robert (1997) through empirical research found that business processing speed and reliability of equipment; front-line employees have a great impact on customer satisfaction (Johnston and Robert 1997). Cocheo et al. (2003) study found that commercial banks whether provide the everywhere financial service have a great impact on the bank customer satisfaction (Cocheo et al. 2003) Shen and Deng (2003) divided five relative levels which are the range of products and services; service process; service personnel to five associate level to measure the impact factors of customer satisfaction; service brand and image; services and facilities, network settings and distribution (Lei and Limei 2003; Dedong (2004) put the bank image, the expectations and the perception of product or service quality, perceived product or service value, customer satisfaction and customer loyalty as factors affecting China's retail banking customer satisfaction and then establish a specific evaluation model to empirical study (Dedong 2004; Ji 2006), online banking as the research object, research results showed that the bank's overall service capacity, safety, reliability, tangibles, and brand image have a major impact on the quality of online banking services. Among them, the impact on customer satisfaction is tangibles (Ji 2006).

Based on the above research and combine the characteristics of the commercial bank customer service system, and then puts forward this paper's model which shows in Fig. 114.1:

Based on the above measurement model, this study proposes the following hypothesis:

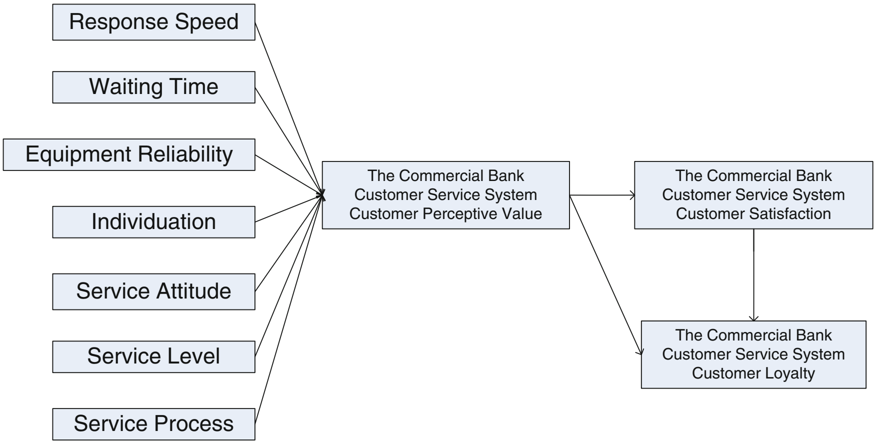

Fig. 114.1 The relationship model of commercial bank customer service system customer perceptive customer satisfaction and customer loyalty

H1: The response speed of the commercial bank customer service system and customer perceived value exist positive correlativity.
H2: The waiting time of commercial bank customer service and customer perceived value exist positive correlation.
H3: The equipment reliability of commercial bank customer service system and customer perceived value exist positive correlativity.
H4: The individuation of commercial banks customer service system and customer perceived value exist positive correlativity.
H5: The service attitude of commercial bank customer service system and customer perceived value exist positive correlativity.
H6: The service level of commercial bank customer service system and the customer perceived value exist positive correlativity.
H7: The service process of commercial bank customer service system and customer perceived value exist positive correlativity.
H8: The customer perceived value of commercial bank customer service system and customer satisfaction exist positive correlativity.
H9: The customer perceived value of commercial bank customer service system and customer loyalty exist positive correlativity.
H10: The satisfaction of commercial bank customer service system and customer loyalty exist positive correlativity.

114.3 Empirical Analysis

114.3.1 Questionnaire Structure and Data Collection

The questionnaire of this study mainly consists of two parts. The first part is the description of the basic situation of the sample. The second part is the problem items of the questionnaire. At first, we release 80 questionnaires for predict pretest and collect 63 valid samples among these questionnaires. Through the calculation, we find that the Cronbach Alpha coefficients is 0.918, In other words, the analysis results are reliable according to this questionnaire surveys.

This study selected the customers of commercial banks for the survey. Considering the actual situation, the data of study mainly contains two parts: part of the data source of field research, another part of the data source of the network which includes forums, online research platform and e-mail questionnaires. The research total releases questionnaires 600, under removing 85 invalid and unqualified questionnaires. At last, we obtain valid questionnaires 515; the recovery of questionnaire is 89.4 %. Specific characteristics of the sample surveyed are shown in Table 114.1:

114.3.2 The Reliability and Validity Inspection of the Scale

- Reliability Analysis

This article use SPSS16.0 for the Reliability Analysis and the Cronbach Alpha coefficients between 0.00 and 1.00, the higher the coefficient, the stronger internal consistency of the questionnaire. From the Table 114.2 we can see the Cronbach Alpha coefficients of this questionnaire.

Table 114.1 Sample characteristics

Item description		proportion
Sex	Men	47.9 %
	Woman	52.1 %
Age	Below 20 years old	10.9 %
	20–30 years old	37.8 %
	30–40 years old	32.8 %
	Above 40 years old	18.5 %
Degree	Specialist and below specialist	9.4 %
	Undergraduate	42.7 %
	Master	28.1 %
	Doctor and above doctor	19.8 %

Table 114.2 The reliability coefficient of variables measuring

Variables	Cronbach's alpha
Response speed	0.826
Waiting time	0.842
Equipment reliability	0.873
Individuation	0.809
Service attitude	0.708
Service level	0.854
Service process	0.835
Customer perceptive Value	0.796
Customer satisfaction	0.827
Customer loyalty	0.846
Total	0.862

From Table 114.2, we can see that the Cronbach Alpha coefficients of the whole questionnaire is 0.862, and each variable Cronbach Alpha coefficients were higher than 0.7 which indicate that the questionnaire has high credibility.

- Validity Analysis

In this study, we use factor analysis to test the construct validity of the questionnaire. Through KMO inspection and Bartlett's test find that the values of KMO is 0.857 (more than 0.7) to these variables, and the significant level of Bartlett's test is 0.000, indicating that the data is normal distribution and can carry on the factor analysis. Specific results showed in Tables 114.3 and 114.4

From Tables 3.3 and 3.4, we can see the factor loadings higher than 0.6 except V4 and V18.

114.3.3 Hypothesis Test

- Calculation Impact Factors Weights on Customer Perceptive Value

This study use SPSS16.0 proceeding regression analysis to investigation data, for calculate the weight of consumers to consumer perception value of the commercial bank customer service system. The greater the regression coefficients showed that it changes on the proportion of the commercial bank customer service system customer perceptive value evaluation is bigger; deciding in customer satisfaction and customer loyalty is the more important aspects. We put the customer perceptive value to set the dependent variable, putting the seven factors of the factor analysis set to the independent variable and multiple regression analysis, results such as shown in Table 114.5

Form the Table 114.5 we can see that it exists the significant positive correlation between other various factors and overall customer perceptive value except service process. Among them waiting time, service level, service attitude and

Table 114.3 The factor loading of exogenous variables

Index	Factor name						
	Response speed	Waiting time	Equipment reliability	Individuation	Service attitude	Service level	Service process
V1		0.867					
V2		0.891					
V3		0.842					
V4	0.549						
V5	0.692						
V6	0.728						
V7						0.884	
V8						0.827	
V9				0.768			
V10				0.819			
V11				0.846			
V12				0.869			
V13							0.859
V14							0.882
V15							0.782
V16							0.729
V17		0.659					
V18		0.572					
V19					0.817		
V20					0.795		
V21					0.837		
V22					0.772		

Table 114.4 The Factor loading of exogenous variables

Index	Factor name		
	Customer perceptive value	Customer satisfaction	Customer loyalty
V1		0.867	
V2		0.881	
V3		0.849	
V4		0.827	
V5	0.826		
V6	0.772		
V7	0.859		
V8	0.792		
V9			0.815
V10			0.768
V11			0.836

equipment reliability these four variables to the commercial bank customer service system customer perceptive value will greatly influence, and regression coefficient is positive and greater than 0.2, explaining that the relationship between these six

Table 114.5 Multiple regression analysis results of customer perceptive value

Model	Unstandardized coefficients		Std coefficient	T	Sig	Multiple liner inspection	
	B	Std error	Beta			Tolerance	VIF
Coefficient	0.627	0.115		6.325	0.000		
Response speed	0.182	0.026	0.186	5.627	0.000	0.758	1.267
Waiting time	0.236	0.021	0.241	3.245	0.008	0.862	1.489
Eqpt reliability	0.208	0.017	0.215	2.368	0.009	0.873	1.652
Individuation	0.162	0.024	0.159	3.953	0.000	0.724	1.528
Service attitude	0.214	0.028	0.218	7.268	0.001	0.861	1.467
Service level	0.223	0.025	0.234	6.384	0.000	0.834	1.292
Service process	0.159	0.008	0.164	7.589	0.125	0.792	1.482

Dependent Variable: Customer Perceptive Value $R^2 = 0.658$, $AdjR^2 = 0.672$, $F = 357.354$, $p = 0.000$, Durbin-Waston = 1.792

variables and customer perceived value is the positive correlation, service process not included in this, and this assumption that do not get the support.

At the same time from Table 3.5 reveals, we can infer that the order of these six independent variables to customer perceptive value the influence degree from strong to the weak is waiting time > service level > service attitude > equipment reliability > response speed > personalized.

- The relationship among commercial bank customer service system customer perceptive value, customer satisfaction and customer loyalty

This study put the customer satisfaction and customer loyalty of the commercial bank customer service system are respectively set to the dependent variable, the guests' perceptive value and customer satisfaction are respectively set to the independent variable and multiple regression analysis, the specific results such as Table 114.6 shows:

According to the result of the regression analysis, we can reach the following three regression equation of the commercial bank customer service system customer perceptive value, customer satisfaction and customer loyalty:

Customer Satisfaction (TS) = 1.684 + 0.782* Customer Perceptive Value
Customer Loyalty (CL) = 1.842 + 0.827* Customer Perceptive Value
Customer Loyalty (CL) = 1.591 + 0.898* Customer Satisfaction

Table 114.6 The results of regression analysis between customer perceptive value, customer satisfaction and customer loyalty

	Constant value	Regression coefficient	T Figure	P
Customer perceptive value and customer satisfaction	1.684	0.782	4.957	0.019
Customer perceptive value and customer loyalty	1.842	0.827	3.297	0.000
Customer satisfaction and customer loyalty	1.591	0.898	4.128	0.005

114.4 Conclusion

Through calculation of the weight of each factor that, we can see that other assumptions are established besides assumptions seven. This shows that response speed, waiting time, equipment reliability, personalized, service attitude and service level is the influence factors of the commercial bank customer service system customer perceptive value, and for the same impact role. In order to further study the relationship of the customer perceptive value, customer satisfaction and customer loyalty of commercial bank customer service system, we put the commercial bank customer service system customer satisfaction and customer loyalty to set the dependent variable, the customer perceptive value and customer satisfaction set to the independent variable and multiple regression analysis. Finally come to customer perceptive value to the customer loyalty slightly greater than the effect of customer satisfaction, and customer perceptive value for customer satisfaction influence is greater than the customer satisfaction to the customer loyalty, showing that the commercial bank customer service system from the customer perceptive value angle, concentrate on their own service quality, meet the diverse needs of customers, and improve the customer satisfaction level, for their own gain greater market share laid solid foundation.

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Chapter 115
Time Series Data Modeling and Application

He Gao, Xiao-li Cai and Yu Fei

Abstract We presents some commonly used methods to model the nonstationary time series. Based on these methods, we propose a model to study the relationship between the gross exports and gross domestic product (GDP) from 1982 to 2004 in China. The presented model gives a proper illustration on the relationship between gross exports and GDP.

Keywords GDP · Gross exports · Time series

115.1 Nonstationary Time Series Model Building

Classical time series analysis is based on the theory of stationary processes. Most stationary processes can be approximated by a model from the class of autoregressive moving average (ARMA) models (Tiao and Grupe 1980; Chen et al. 1995; Ling and Li 1997). However, few econometric time series are stationary. For many nonstationary time series, they can be approximated by an ARMA model after differencing or some other transformation (Dickey and Fuller 1981;

H. Gao (✉)
School of Business and Tourism Management, Yunnan University,
Kunming, China
e-mail: gaohe@ynu.edu.cn

X. Cai
Department of Business Administration,
Zhengzhou Institute of Aeronautical Industry Management, Zhengzhou, China
e-mail: lily_ccxl@163.com

Y. Fei
Statistics and Mathematics College, Yunnan University of Finance and Economics,
Kunming, China
e-mail: feiyukm@yahoo.com.cn

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Engle and Granger 1987). This paper proposes some commonly used model-building methods to study the relationship between the gross exports and gross domestic product (GDP) in China (Johansen and Juselius 1990; Kwan and Cotsomitis 1990; Xu and Lai 2001; Xu and Lai 2002; Xu 1996; Zhang 2000). The model building methods for nonstationary processes will be presented in Section I. In Section II, based on these methods, the data of gross exports and GDP from 1982 to 2004 in China will be analyzed. We will see that the model presented in this paper gives a proper illustration on the relationship between gross exports and GDP.

115.1.1 Integration and Unit Root Test

A nonstationary series $\{y_t\}$ is integrated of order, denoted by $y_t \sim I(d)$, if it becomes stationary after first d times differencing. The well-known autoregressive integrated moving average (ARIMA) class of models can be used to approximate such nonstationary process.

We consider the ARIMA (p,d,q) model which can be written as follows

$$\Phi(L)(1-L)^d y_t = \Theta(L)u_t$$

where L is lag operator, $\Phi(L) = \sum_{i=o}^{p} \phi_i L^i$ is auto-regressive operator, $\Theta(L) = \sum_{i=o}^{q} \theta_i L^i$ is moving-average operator, and u_t is white noise series. If the characteristic equation $\Phi(L) = 0$ has an unit root 1, the series is nonstationary. Augmented Dickey-Fuller (ADF) test, presented by ickey-Fuller (1981), is due to test both stationarity and order of integration. There are three types regression models for ADF test.

$$\Delta y_t = \gamma y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + u_t$$
$$\Delta y_t = \alpha + \gamma y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + u_t$$
$$\Delta y_t = \alpha + \delta t + \gamma y_{t-1} + \sum_{i=1}^{p} \beta_i \Delta y_{t-i} + u_t$$

where the test hypothesis is $H_0 : \gamma = 0 \leftrightarrow H_1 : \gamma < 0$.

115.1.2 Cointegration Test

Suppose $y_t = (y_{1t}, y_{2t}, \ldots, y_{kt})^T$ is the $k \times 1$ time series vector, if (a) every $y_{it} \sim I(d)(i = 1, 2, \ldots, k)$; (b) exist a $k \times 1$ nonvanishing vector β such that $\beta^T y_t \sim I(d - b)$. We call y_t cointegration with order (d, b), denoted by $y_{it} \sim CI(d, b)$, where β is cointegrated vector.

Consider ADF test model with order (1.1) as follows

$$y_t = \alpha_0 + \alpha_1 y_{t-1} + \beta_0 x_t + \beta_1 x_{t-1} + u_t \tag{115.1}$$

where $u_t \sim i.i.d.(0, \sigma^2)$. We denote $y_t^* = E(y_t)$ and $x_t^* = E(x_t)$. Noting that $E(u_t) = 0$, we take the expectation both sides of Eq. (115.1) to obtain

$$\begin{aligned} & y_t^* = \alpha_0 + \alpha_1 y_t^* + \beta_0 x_t^* + \beta_1 x_t^* \\ & \Rightarrow y_t^* = \tfrac{\alpha_0}{1-\alpha_1} + \tfrac{\beta_0+\beta_1}{1-\alpha_1} x_t^* = k_0 + k_1 x_t^* \end{aligned}$$

where $k_0 = \frac{\alpha_0}{1-\alpha_1}$, $k_1 = \frac{\beta_0+\beta_1}{1-\alpha_1}$ and k_1 is the long run multiplier which measures the long term balance relationship between y_t and x_t.

On the other hand, Eq. (115.1) can be written as

$$\begin{aligned} \Delta y_t = & \alpha_0 + \beta_0 \Delta x_t + (\alpha_1 - 1)(y_{t-1} - x_{t-1}) + (\alpha_1 + \beta_0 + \beta_1 - 1) x_{t-1} \\ & + u_t = \alpha_0 + \beta_0 \Delta x_t + (\alpha_1 - 1)(y_{t-1} - k_1 x_{t-1}) + u_t \end{aligned} \tag{115.2}$$

where $(\alpha_1 - 1)(y_{t-1} - k_1 x_{t-1})$ is the error correction term, $(y_{t-1} - k_1 x_{t-1})$ is disequilibrium error, and $(\alpha_1 - 1)$ is the adjusted velocity of $(\alpha_1 - 1)(y_{t-1} - k_1 x_{t-1})$ to Δy_t, which is called correction coefficient. Equation (1.2) is called error correction model (ECM).

Engle-Granger two-step method presented by Engle and Granger (1987) can be used to estimate the parameters in ECM. First, we use ordinary least squares (OLS) to estimate cointegration parametric vector, this procedure is called cointegrating regression or static regression.

Consider time series $y_t, x_{1t}, x_{2t}, \ldots, x_{(k-1)t}$, and build the regression model as

$$y_t = \beta_1 x_{1t} + \beta_2 x_{2t} + \cdots + \beta_{k-1} x_{(k-1)t} + u_t \tag{115.3}$$

Based on (115.3), cointegrating vector $(1, \beta_1, \beta_2, \ldots, \beta_{k-1})^T$ can be estimated by using OLS method. Corresponding residual $\hat{u}_t$ is given by

$$\begin{aligned} & \hat{u}_t = y_t - \hat{\beta}_1 x_{1t} - \hat{\beta}_2 x_{2t} - \cdots - \hat{\beta}_{k-1} x_{(k-1)t} \\ & \Rightarrow \Delta \hat{u}_t = \gamma \hat{u}_{t-1} + \sum_{i=1}^{k} \rho_i \Delta \hat{u}_{t-i} + \in_t \end{aligned}$$

Then we can test $\hat{u}_t$ by using ADF approach for the following hypothesis

$H_0 : \gamma = 0$ ($\hat{u}_t$ is nonstationary series) $\leftrightarrow H_1 : \gamma \neq 0$,

($\hat{u}_t$ is stationary series)

Secondly, adding $\hat{u}_t$ as error correction term to ECM, we have

$$\Delta y_t = \alpha \Delta x_t + \delta \hat{u}_t + u_t$$

Then we can estimate the short run parameter α and δ by using OLS method.

115.1.3 Granger Causality Test

If a variable is affected by another lagged variable, there is Granger causality between them. Granger causality test is due to test whether the lagged variable is needed to put into the equation proposed.

Consider two variables X and Y, and corresponding model as follows

$$Y_t = \sum_{i=1}^{m} \alpha_i X_{t-i} + \sum_{i=1}^{m} \beta_i Y_{t-i} + u_{1t} \tag{115.4}$$

when all of $\alpha_i (i = 1, \ldots, m)$ equal 0, X is not the Granger causation of Y. F-test can be used to test the following hypothesis

$H_0 : \alpha_i = 0 (i = 1, \ldots, m) \leftrightarrow H_1$: exit one $\alpha_i \neq 0$ at least

The test statistic is

$$F = \frac{(RSS_0 - RSS_1)/m}{RSS_1/(T-k)} \sim F(m, T-k)$$

where m is the order of lag term, T is sample size, k is the number of parameter including constant term, RSS_0 is residual sum of squares of the equation $Y_t = \sum_{i=1}^{m} \beta_i Y_{t-i} + \in_t$ without the lag variables of X, and RSS_1 is the residual sum of squares of the Eq. (115.4).

115.2 Example

This section is going to build a nonstationary model by using the data of gross exports (EX) and GDP from 1982 to 2004 in China. The data are given in Table 115.1.

In order to eliminate heteroskedasticity in the model, taking logarithmic transformation for the series of EX and GDP, we obtain the new series log(EX) and log(GDP), denoted by LEX and LGDP respectively. We test the stationary of LEX and LGDP by using ADF test. The ADF test results are given in Table 115.2.

From Table 115.2, we can conclude that LEX and LGDP are nonstationary series. But they become stationary after first order differencing. Therefore LEX and LGDP are both I(1).

Table 115.1 China's gross exports and GDP (1982–2004) (unit: hundred million us dollars)

Years	Goods export	Service export	EX	GDP
1982	211.25	25.12	236.37	2899.736
1983	207.07	24.79	231.86	3075.051
1984	239.05	28.11	267.16	3088.103
1985	251.08	30.55	281.63	2993.871
1986	257.56	38.27	295.83	2934.662
1987	347.34	44.37	391.71	3165.955
1988	410.54	48.58	459.12	3950.458
1989	432.2	46.03	478.23	4372.394
1990	515.19	58.55	573.74	3829.487
1991	589.19	69.79	658.98	3998.046
1992	695.68	92.49	788.17	4689.768
1993	756.59	111.93	868.52	5987.712
1994	1025.61	166.2	1191.81	5417.372
1995	1281.1	191.3	1472.4	7006.658
1996	1510.77	206.01	1716.78	8218.518
1997	1826.7	245.69	2072.39	9034.5
1998	1835.29	238.95	2074.24	9542.499
1999	1947.16	262.48	2209.64	9986.724
2000	2491.31	304.305	2795.615	10792.05
2001	2660.75	333.34	2994.09	11911.67
2002	3256.51	397.445	3653.955	13035.88
2003	4382.7	467.336	4850.036	14707.02
2004	5933.93	624.341	6558.271	17203.99

Note The data come from Financial database of IMF (http//ifs.apdi.net)

Table 115.2 ADF Test for LEX and LGDP

Variables	Test type (c,t,k)	ADF-stat.	Critical value	Conclusion
LEX	(c,0,1)	1.1197	−3.0114	Nonstationary
Δ LEX	(c,0,1)	−2.6851	−2.6502*	Stationary
LGDP	(c,0,1)	0.8443	−3.0114	Nonstationary
Δ LGDP	(c,0,1)	−3.9204	−3.0199	Stationary

Note (a) In the test (c,t,k), c is constant, t is trend term and k is the lagged order; (b)* is the critical value for 0.10 significance level and others for 0.05 level

Based on the result of Table 115.2, we can build the cointegrating regression equation of LEX and LGDP as follows

$$LGDP = 4.832397398 + 0.559560933LEX$$

Table 115.3 Adf test for residual series

Variables	Test type (c,t,k)	ADF-stat.	Critical value	Conclusion
e_t	(c,0,1)	−3.2006	−3.0114	Stationary

Table 115.4 Granger causality test for LEX and LGDP

Null hypothesis H0	Lagged order p	F-stat.	Prob.	Conclusion
LGDP is not GC of LEX	1	0.09	0.78	Accept H0
LEX is not GC of LGDP	1	25.389	0.00	Refuse H0
LGDP is not GC of LEX	2	0.01	0.99	Accept H0
LEX is not GC of LGDP	2	14.35	0.00	Refuse H0
LGDP is not GC of LEX	3	0.19	0.90	Accept H0
LEX is not GC of LGDP	3	11.07	0.00	Refuse H0
LGDP is not GC of LEX	4	0.19	0.94	Accept H0
LEX is not GC of LGDP	4	11.75	0.00	Refuse H0
LGDP is not GC of LEX	5	0.05	1.00	Accept H0
LEX is not GC of LGDP	5	6.37	0.02	Refuse H0
LGDP is not GC of LEX	6	0.27	0.92	Accept H0
LEX is not GC of LGDP	6	4.48	0.08	Accept H0

Note GC is a short for Granger causality. The significance level for the Granger causality test is 0.05

$$(t = 35.96506)\ (t = 29.0272) \tag{115.5}$$

where adjusted $R^2 = 0 \cdot 974525,\ F = 842.5785\ (prob. = 0.0000),\ AIC = -1.80861.$

Based on (115.5), we obtain the residual series $\{e_t\}$. We use the ADF test to test whether the residual series $\{e_t\}$ is nonstationary or stationary. The ADF test results are listed in Table 115.3.

Table 115.4 gives the testing results of LEX and LGDP by using the method of Granger causality test.

From the testing result, we can conclude that LEX and LGDP are both cointegrated. Regression shows that GDP is affected by export and they are the positive correlation.

Using OLS method, we can build the ECM of LEX and LGDP as follows

$$\begin{aligned} D(LGDP) =& 0.077 + 0.029D(LEX) - 0.743ECM(-1) \\ & (t = 2.571)\ (t = 0.172)\ (t = -4.278) \end{aligned}$$

where adjusted $R^2 = 0.44005,\ F = 9.25459\ (prob. = 0.0016),\ AIC = -2.22548$

Since the lagged order of economic time series is usually less than six years. We select different lagged order from 1 to 6 to test Granger causality of LEX and LGDP. From Table 115.4, we can see that the conclusions are consistent except the case where p equals six. So we can conclude that export and GDP exist a single-directional Granger causality. That is to say that LEX is the Granger cause to LGDP, but not vice versa. From the test mentioned above, we can draw a conclusion that China's export and GDP is dynamic equilibrium in the long-run. It illustrates that the export led growth hypothesis works in China. But economic growth has not yet shaped scale-effect to exports. The exports growth mostly depends on policies of trade and institution of China.

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Chapter 116
Trilateral Game-Based Research on Low-Carbon Logistics Development Mode

Feng-hua Gao and Rui-hua Gao

Abstract With the development of low-carbon economic, low-carbon logistics is becoming to attract the world's attention. And the development of China's low-carbon logistics is just at the very beginning, there are still several aspects need to be improved. This paper discussed the interactions among the government, logistics enterprises and financial institutions in the implementation process of the low-carbon logistics, by using game theory, and established the framework of China's low-carbon logistics development mode, which is of certain guiding significance for the development of China's low-carbon logistics.

Keywords Financial support · Institutional support · Low-carbon logistics · Trilateral game

As the development of low-carbon technologies and low-carbon concept, the low-carbon economic development model with the low energy consumption, low pollution and low-emission characteristics, has attracted the world's attention. Logistics is a large energy consumption industry, which plays an important role in the low-carbon economy. On the one hand, the development of low-carbon logistics can boost the low-carbon economy development, by reducing energy consumption and carbon emissions in the logistics industry (Li and Lu 2009); on the other hand, the development of low-carbon economy needs modern logistics' support. Advanced logistics operation can support the production and lifestyle of low-carbon economy (Xu 2011). Therefore, to explore our low carbon logistics development model and strategy has theoretical value and practice value.

F. Gao (✉)
School of Management, Shandong University, Jinan, China
e-mail: fenghua1207@163.com

R. Gao
International Colleges, Qingdao University, Qingdao, China

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116.1 Overview of Low-Carbon Logistics

116.1.1 Description of Low-Carbon Logistics

Low-carbon logistics is derived on the basis of "low-carbon economy", which can be understood as "Under the context of addressing global warming, based on the theories of scientific development, low-carbon economy and logistics management, low-carbon logistics is to inhibit the pollution logistics activities, reduce resource consumption, use advanced low-carbon logistics technology to plan and implement low-carbon logistics activities, with the basic requirements of energy conservation, emissions reduction and low-carbon development (Jiang and Wu 2011). Its goal is to build a low-carbon logistics development model and make both society and environment benefit from this.

116.1.2 Basic Requirements for Developing Low-Carbon Logistics

1. *Institutional demand for developing low-carbon logistics*: At present, the development of logistics is still in the extensive stage in China, which is with poor specialization and high cost of logistics. In this case, the cost for the logistics enterprises to implement low-carbon logistics is very high, and therefore the active participation and support of government are important (Rodrigue et al. 2009). As the leader and policymaker of driving the society towards a low carbon model, the government should learn from foreign experiences and lessons of developing low-carbon logistics, making and perfecting related laws and regulations, to form the long-term mechanism of low-carbon development in the logistics industry. Government should play a leading and boosting role in the development of low-carbon logistics. Only being driven by the government, can the logistics enterprises and research institutes be able to follow up the development.
2. *Financing demand for developing low-carbon logistics*: The development of low-carbon logistics has positive externalities. To implement the low-carbon logistics approach, logistics enterprises need a certain capital investment, and the adjustment on original means of transport and route requires a large amount of spending. Consequently, it's difficult for a single enterprise to complete it (Lei 2007). And in order to seek maximum benefits, the enterprise will not necessarily take the initiative to carry out the low-carbon logistics innovation. Therefore, the development of low-carbon logistics needs the support of low-carbon finance. Relevant banks ought to increase the amount of credit to low-carbon logistics projects, improve the support on low-carbon logistics.
3. *Practicing demand for developing low-carbon logistics*: Logistics enterprise is the practice main body of the development of low-carbon logistics. Logistics

enterprises' active participation is very important to ensure low-carbon logistics project's implementation. Because of the high cost of practicing, a lot of logistics enterprises in our country are not actively in the implementation of low-carbon logistics (Turkay et al. 2004). In order to promote the development of low-carbon logistics industry in China, we must boost the logistics enterprises to implement the low-carbon logistics, attract most of the logistics enterprises to actively participate in.

116.2 Trilateral Game of Government, Logistics Enterprises and Financial Institutions

Based on the analysis of institutional demand, practicing demand and financing demand for developing low-carbon logistics, government, logistics enterprises and financial institutions become important participants in promoting the development of low-carbon logistics in China. But the cooperation mechanism of the three haven't been fully formed, the operating mode of China's low-carbon logistics still need further improvement. Through the quantitative analysis from the micro-relations of the three, researching on the internal characteristics and influencing factors of government, logistics enterprises and financial institutions' cooperation, and propose appropriate solutions is of great significance for the low carbon logistics industry's further development (Khoo et al. 2001).

116.2.1 The Basic Assumptions

1. *Assume that the game has three participants*: The government, introducing policies to support the development of enterprises' low-carbon logistics; logistics enterprises, the practitioner of low-carbon logistics; financial institutions, providing financial support for logistics enterprises.
2. *The hypothesis of economic man*: The purpose of the participants is to maximize their own gains.
3. Assumes that in this situation, the game is a whole information static game between the three parties (Ferrero et al. 1998).

116.2.2 Establishing the Static Game Model

This paper builds the trilateral game model of low-carbon logistics development with three partners: government, logistics enterprise and financial institution. The main variables in the model include:

Government subsidy is θ, and subsidy for the logistics enterprise who implements low-carbon logistics is θ_e; subsidies for financial institution who supports the development of low-carbon logistics is θ_f. The government prize ratio to the financial institution for outstanding achievements in low-carbon logistics project is ω ($\omega \geq 0$) (Hobbs 2001). The opportunity cost rate of government subsidy is α ($\alpha \geq 0$). The tax rate on logistics enterprise who implements low-carbon logistics projects is λ ($0 \leq \lambda$ is ≤ 1), the ratio of the corresponding revenue owed to the government is β ($0 \leq \beta \leq 1$). The effort that logistics enterprises invest is E_e, the cost of the effort is $C(E_e)$. Financial institutions provide credit for logistics enterprises to implement low-carbon logistics, the interest fees on loans is I (I $\geq$ 0). The effort that financial institutions invest is E_f, the cost of the effort is $C\left(E_f\right)$. Enterprises' corresponding income for implementing low-carbon logistics is G, G is a function of θ, θ, E_e, E_f (Thompson and Hart 2006). After the successful implementation of low-carbon logistics, the government, the logistics enterprise and the financial institution will all benefit from it.

The implementation of low-carbon logistics in logistics enterprises requires the efforts of the government, enterprises and financial institutions, three aspects are indispensable (Wu and Dunn 1995). Otherwise low-carbon logistics project will lack practicing motivation. And the corresponding income of low-carbon logistics will be zero.

Based on the above assumptions and analysis, the benefit of government, logistics enterprises, financial institutions are as follows: Expected benefit of government:

Expected benefit of government:

$$\gamma_g = \mathrm{G}(1-\beta)\lambda + \mathrm{G}\cdot\beta - (1+\alpha)\theta \tag{116.1}$$

Expected benefit of logistics enterprises:

$$\gamma_e = \mathrm{G}(1-\beta)(1-\lambda) + \theta_e - C(E_e) \tag{116.2}$$

Expected benefit of financial institutions:

$$\gamma_f = \mathrm{G}(1-\beta)\omega + I + \theta_f - C\left(E_f\right) \tag{116.3}$$

116.2.3 Analysis and Discussion of the Static Game Model

In the tripartite game of the government, logistics enterprises and financial institutions, the government is in a leadership position. After the government made decisions on supporting policies, entrance mechanism, tax incentives, subsidies and the ratio of the revenue owed to the government, the logistics enterprise and the financial institution will make their best decisions according to the actual situation.

Conditions of revenue maximization for the logistics enterprise:

$$(1-\beta)(1-\lambda)\frac{\partial G}{\partial E_e} = C'(E_e) \tag{116.4}$$

Conditions of revenue maximization for the financial institution:

$$(1-\beta)\omega\frac{\partial G}{\partial E_e} = C'(E_f) \tag{116.5}$$

Through static analysis, results show that the initiative of logistics enterprises' and financial institutions' participate in low-carbon logistics projects are affected by government policies. When the Government's tax incentives enhanced, or the ratio of the revenue owed to the government reduced, the enterprises will be encouraged to implement low-carbon logistics; otherwise the enterprises' effort level will drop. For the financial institutions, when tax incentives enhanced and return on investment increased, they will be encouraged to support low-carbon logistics development. This shows that government subsidies and tax, financial institutions' support are very essential for encouraging logistics enterprises to make more active efforts in the development of low-carbon logistics.

116.3 The Establishment of Low-Carbon Logistics Development Mode

This study shows that the tripartite efforts of the government, logistics enterprises and financial institutions are indispensable in the development process of China's low-carbon logistics. In the tripartite game, the government is in a leadership position. Government provides subsidy and preferential policies for the development of low-carbon logistics; logistics enterprises and financial institutions will make their best decisions according to the government's policies (Lee and Billington 1995). In this paper, based on the former research and discussion, we build the low-carbon logistics development mode on the basis of institutional support and financial support, as shown in Fig. 116.1.

116.3.1 Institutional Support of the Government

Due to the self-interest and competitive in the market, it's uncertain to guide the logistics enterprises to implement low-carbon logistics relying on market mechanisms completely. Therefore it's very necessary for the government to manage, restrain and encourage the logistics subject; the Government must provide reasonable institution arrangement.

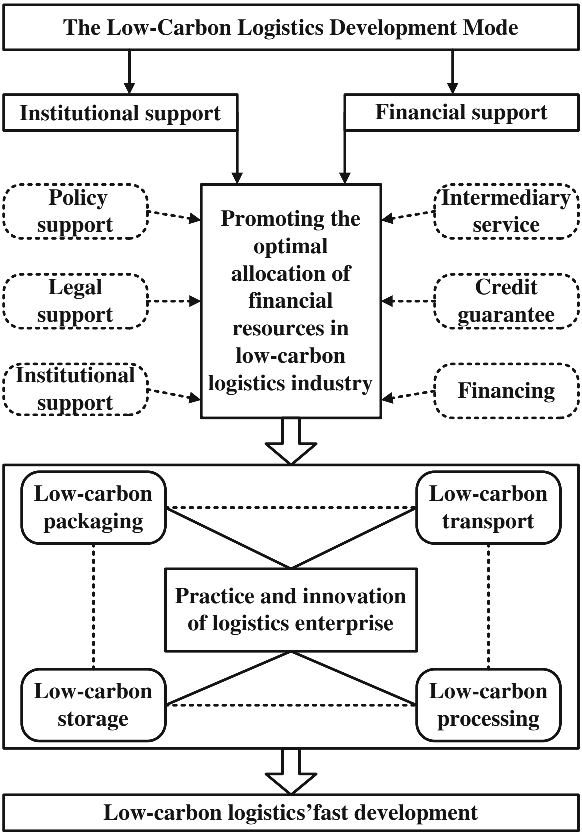

Fig. 116.1 The low-carbon logistics development mode on the basis of institutional support and financial support

1. *Low-carbon logistics policy support system*. First, the government should provide financial subsidies, help the low-carbon logistics enterprises to introduce low-carbon technologies and develop innovative low-carbon products. Second, the government should offer tax relief policy. Government should adjust the non-standard tax categories and strengthen financial support for low carbon logistics enterprises by reducing tax rates, setting appropriate tax threshold and tax exemption (Stock 1992). The third, the government should provide financial concessions for the logistics enterprises. Government may provide a certain amount of loan assistance, loan guarantees and discount interest on loans.
2. *Low-carbon legal and institutional system.* On the one hand, the Government should actively improve the legal and institutional environment of the low-carbon logistics, to guide the development of low-carbon logistics enterprises and protect their legitimate rights and interests; on the other hand, financial institutions play a important role in financing and regulating. They should establish and improve the low-carbon financial institution and system.

116.3.2 The Support of Financial Institutions

Low-carbon capital supply system is the important guarantee for low-carbon logistics enterprises to obtain the necessary funds. In order to expand the diversification of low-carbon financing way, first it's necessary to broaden direct financing channels, such as bonds, equities and commercial credit and other forms of financing. Second, promoting the indirect financing for low-carbon logistics is also very important, including developing low-carbon credit, establishing and improving the low-carbon credit department (Department for Transport 2009). Besides this, financial institutions' issuance of securities and designing loan types to accommodate the characteristics of low-carbon logistics enterprises are also very useful. At the same time, the financial institutions also should build low-carbon credit guarantee system and low-carbon intermediary service system.

116.3.3 Practicing Efforts of Logistics Enterprises

Learn from the experience of developed countries in implementing low-carbon logistics, logistics enterprises in China can control energy consumption and reduce carbon emissions from specific operation of the process. More specifically, there are four aspects. First, using low-carbon packaging and standardized packaging, to ensure that, the whole process of product packaging from raw material selection, product manufacture, using, recycling to wasting is in line with the requirements of environmental protection (Pachauri and Reisinger 2007). Second, implementing low-carbon transport to promote the development of low-carbon logistics, by reducing the ratio of motor transport, enhancing the proportion of multimodal transportation, using low-carbon energy vehicles, large trucks, special trucks, carrying out the optimization of transport routes, and implementing the joint transportation. The third, the development of low-carbon storage is also very important. Logistics enterprises should actively use advanced equipment and technology of low-carbon storage to reduce energy consumption; using advanced planning techniques of storage to improve storage efficiency and reduce the impact on the environment (Han and Liming 2011). The fourth, building the low-carbon processing to reduce environmental pollution, by developing the professional centralized processing, centralized processing the scrap and improving the resource utilization efficiency (Nader 2009).

116.4 Conclusion

From the long-term targets of sustainable social development and environmental protection, although there are some obstacles like the high cost in the implementation of low-carbon logistics, low-carbon logistics still will be a trend for future logistics. Government should play a positive role in organizing, coordinating and leading the development of low-carbon logistics. The government should use the advantages on economic policy, finance and public opinion, and actively try hard to help logistics enterprises to implement low-carbon logistics, which is very important for the sustainable development of society. As profit organizations, corporations and financial institutions also should take social responsibility and actively participate in promoting the development of low carbon logistics, and make a perfect match between their own profit targets and social responsibility.

This paper discussed the interactions among the government, logistics companies and financial institutions in the implementation process of the low-carbon logistics, by using game theory, and established the framework of China's low-carbon logistics development mode, which is of certain guiding significance for the development of China's low-carbon logistics.

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Chapter 117
Reform and Innovation of Development of Enterprise Electronic Commerce in Management

Yan Li

Abstract In order to improve the ability of innovation of electronic commerce on management the paper proposes the method and measure on management. Firstly the establishment and implementation customer relates management in electronic commerce is debated. Then the method on human resource for electronic commerce is proposed. In the production the changing the mode of production to satisfy customer's need is given. Then the traditional marketing and network marketing is proposed for the electronic commerce. Lastly the conclusion is given.

Keywords Electronic commerce · Reform and innovation · Management

117.1 Introduction

The enterprise usage of electronic commerce will creatively bring promotion on management (Crespo and Del Bosque 2008a). Enterprise is in the process of carrying out electronic commerce. The ability of innovating decides that the enterprise core competing ability is the most important factor of ability. It particularly has to value management innovation and electronic commerce to go with. Enterprise completely practices management innovation will better improve the application and development of electronic commerce. The enterprise should pay attention to strengthen management as follows at each aspect innovation in the process of making use of electronic commerce to carry on managing innovation (Bowersox et al. 2006).

Y. Li (✉)
School of Economy and Management, Zhongyuan University of Technology,
Zhengzhou 45007, People's Republic of China
e-mail: liyanzzti@163.com

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117.2 The Requirement for Management in Electronic Commerce

117.2.1 The Establishment and Implementation Customer Relation Management in Electronic Commerce

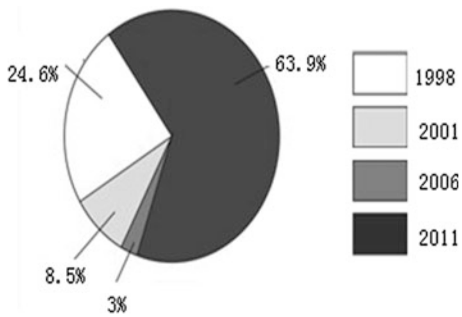
The requirement on the custom relation management on electronic commerce is more and more bigger. The enterprise carries out the changing of customer management. Customer for developing the enterprise of electronic commerce is important. The most enterprise profits are created by least old customers combining of management and electronic commerce system. By the marketing and sale automation and CRM enterprise carries out electronic commerce and promotes organization structure of enterprise development at the same time (Ballou 2003).

After carrying out electronic commerce, the enterprise then can ask for help of network to build up various databases with the lowest cost establishment and long-term close contraction of man-to-man of the customer. The customer's data of enterprise relation management on the customer in the traditional business activity is not complete. This can not change the weaknesses of data like that the customer changes in time because the cost of customer relation management is too high. Enterprise can depend on the store and business agent etc. The cheaper agent organizations carry on contact and make the space distance of enterprise and customer smaller. They contribute efforts to the customer, raise customer's satisfaction, and provide promotion for the customer and characteristic strategy (Crespo and del Bosque 2008b).

Relation management system on the customers is the most important database in the network marketing's process in customer's database formed. In addition to usually the contents of customer's database the contents that it mainly saves should also include the customer's address, E-mail address, the inquiry of product and demands the circumstance of offer on the customer history, the customer's need to the product and dissatisfied information, such as opinion and suggestion etc.

The methods on the customs relation should be adopted to improve the management in electronic commerce. The enterprise should be a customer. At the same time theory instruction and item management method of establishment of whole data warehouse set is promising customer or cooperation. Thus, the colleague can't have risk to carry out with the higher cost on enterprise customer relating management according to the warehouse and the customer. The CRM system of orientation electronic commerce has characteristics such as integrity, concentration etc. The enterprise should design, establish and manage data warehouse and carry out CRM system. The investment risk of customer data warehouse construction declining for minimum, the enterprise should build up solution in the data warehouse facing to different customer's community. Each project should include a series of data structure of the community market which is concerning the customer model, applied model with abundant of statement. The Fig. 117.1 give the

Fig. 117.1 The importance of CRM system in electronic commerce varied from 1998 to 2011 in Chinese small enterprise



importance of CRM system in electronic commerce varied from 1998 to 2011 in Chinese small enterprise.

117.2.2 Requirement for Managing Measure with Human Resource

The knowledge training and broadcast is an important project on electronic commerce. The persons who master the electronic commerce are the important resource on enterprise management. The electronic commerce is a kind of new-born thing to all of any nations. Theoretically it is edge academics. Developing electronic commerce compound need to be crossed academics realm talented person is wanted to master in a calculator network technique, and be wanted to control certain finance, business knowledge. The electronic commerce requires modern information technique to make the enterprise for improving of human resource, for example tests, employ, training and reward etc. Research and education institute is wanted to be in line with nations industry and enterprise. Actively the researcher should study electronic commerce theory and concrete business, enlargement development, accomplishing large numbers of commerce of modern eras. The talented person and modern new entrepreneur are shall to study the business. All things become more and more easy, and the expense also consumedly is lowers. Enterprise outward releases public job advertisement information by passing to publish advertises (Luo et al. 2008). The enterprise releases job advertisement register form on the own website. The one who make to accept appointment can download a form to carry on filling in at any time. Network job advertisement not only can give enterprise but also give appointed worker a great deal of time, energy and money. In order to publishing information such as working problems, outlet, expenses and advertisement etc. The talented person whom the enterprise needs to accept appointment usually can not be draw on. Making use of network job advertisement method the enterprise can renew job advertisement information at any time and announce an empty lack position of enterprise draw on a talented person to come to accept appointment.

117.2.3 The Mode of Production to Satisfy Customer's Need

The mode and structure of management is the biggest changing on management. The customer can by the network to directly participate in a product design and make the one-way type product design of tradition for the double toward the interactive designing method. The enterprise can well develop itself. The characteristics of many species and small batch quantity consuming satisfy different customer's demand. It also produces and makes to meet the product that the customer requests more by the orientation network economic ages (Walton 2006). The production is organizing structure formerly (Waters 2003). The intermediate governor had reached and descended on important function and the network undertook this actor. High-efficiency enterprise has to adopt new production organization structure reorganization. They will redesign the organization management structure. Computers, network technique usage in the market of enterprise investigate and design of product, development, manufacturing realm are using to make order production. The internet-based electronic commerce will change the internal structure of enterprise and production section by declining the cost to influence the production organization structure of enterprise. Enterprise should reconstruct a traditional production process on electronic commerce platform. The manager of enterprise is facing the electronics process from the traditional process changing into an economic network ages in which enterprise raises the development efficiency and improve the new trend of enterprise competition ability.

After carrying out electronic commerce each of production stage can contact mutually by network. They can carry on at the same time. This makes the traditional straight line production become network economy. This proceeds together production reduces much time and raises production efficiency. This is an advantage for the small and medium enterprises to work well on management and overall quality management.

117.2.4 Strengthening the Knowledge Management and Establishing Studying-Type Organization

The electronic commerce makes the enterprise obtain the ability and strength of managing and using knowledge. The enterprise can ask for help of network to collect useful information and knowledge which the enterprise needs. The dissemination and exchanges on knowledge can carry on through the network. It makes the employee's personal knowledge extensively share in the enterprise inner part and become "enterprise knowledge" of fitting exploitation. The electronic commerce makes the enterprise acquire information and knowledge from the market. With the customer building up the shared mechanism of knowledge and information become very important. The enterprise can speed enterprise sharing, exchanging and making use of knowledge. Enterprise can strengthen the knowledge management of enterprise by building up a perfect knowledge database (include customer's database and cooperate colleague's database and product database etc.).

After building up knowledge management system the knowledge of enterprise management is to deposit in document. The employee knowledge and the technical ability collections within brains is get up and taken into organizing in which the knowledge is tidied up and categorized. Then they are managed according to the calculator of database of information system by the search renewal. And the ability of correspondence technique information of information technique and calculator network can be sued in the knowledge management system. These knowledge and technical ability information at suitable time is delivered in time to the employee who needs. In order to provide an appropriate help for work the study-type organization should be built up. All means and technical abilities applied are knowledge in the work. The Fig. 117.2 give the variation of importance of the study-type organization in electronic commerce from 2000 to 2011 in Chinese small enterprise.

But not all knowledge is all essential and important. What knowledge management concerns combines with together decisive knowledge with the business process of enterprise. The knowledge management system is wanted to create knowledge with dissemination and enterprise of business process. Knowledge management is carrying on systematizing management for enterprise business process. It is carrying on the sharing of knowledge and making use of the preface knowledge with higher business level and efficiency. They are making the knowledge in the production process, carrying out increasing in value of knowledge and becoming the source of enterprise profits (Qiu and Li 2008). The enterprise should blend the knowledge management to the electronic commerce system. It is a main management activity in the knowledge management. This obtains an important content of enterprise competitive advantage. In the network economy, the speed decides that the knowledge can improve the competitive advantage and contingency ability of enterprise.

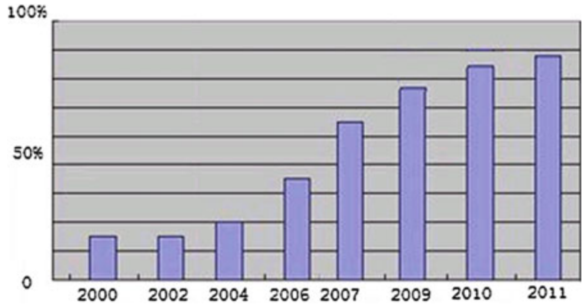


Fig. 117.2 The variation of importance of study-type organization in electronic commerce

117.2.5 The Marketing Integration of Electronic Commerce Strategy

All traditional business activity is similar (Kaplan and Nieschwietz 2003). The electronic commerce can not get away from marketing in the market. Because electronic commerce is in the internet which is virtual place carrying on trading by a certain meaning. This can be thinking that electronic commerce process is marketing in the market. For drawing on a customer the enterprise can adopt marketing strategy in the market. The special strategy can usually bring enterprise the bigger benefits. This things engaged in the enterprise of electronic commerce is particularly important. But because of the characteristics of network oneself the marketing strategy of electronic commerce comparing to the strategy of traditional business have variety, improvement and innovation. The ability of enterprise's electronic commerce in the fierce competition realm is network marketing ability. The cost of network marketing is more and more low. The hint of profit-cost rate of network marketing and traditional marketing is given in Fig. 117.3.

Therefore, it has the necessity of integration for carrying on network marketing and traditional marketing. Traditional marketing and network marketing are two parts of whole enterprise marketing strategy. Among them, the traditional marketing is to create prior condition for network marketing. The network marketing with the characteristic of cheaply, instantly and interaction become the main means by which the enterprise carries out the marketing target. These two parts are lacking relations of integration making it develop the biggest effect.

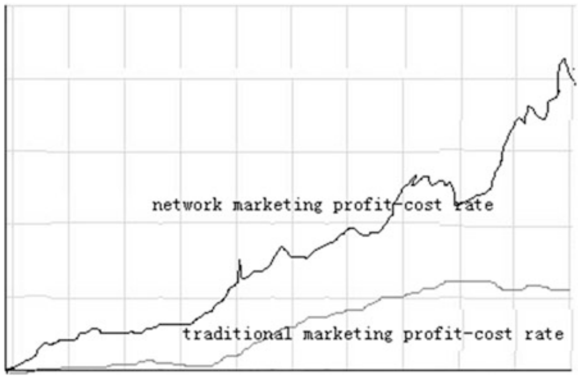


Fig. 117.3 The variation of importance of study-type organization in electronic commerce

117.3 Marketing Strategy of Electronic Commerce

117.3.1 Traditional Marketings

Using of traditional marketing mainly is to carry out the marketing to finish the task for enterprise. The traditional marketing makes use of traditional marketing skill. Enterprise advertisement and enterprise brand are two enterprise main marketing method.

1. *The strategy that carries on the marketing for the enterprise network*

Using of traditional marketing skill enterprise marketing network may guide the consumer to land enterprise website (Zhuang and Zhou 2006). But what have to point out is the enterprise can not make the enterprise website with alone form because making use of traditional marketing skill marketing website, enterprise product, enterprise image information can be advertised with the promotion activity information of enterprise. So it is the basement of network marketing to accept this marketing information. It is the tendency to combine the traditional marketing with network marketing on the enterprise marketing network.

2. *The marketing strategy of brand*

The network marketing needs the consumer to search information so before the consumer purchase or search an information enterprise has to establish a brand image by which enterprise has opportunity to deliver the information to the consumer. Asking for help of traditional medium to establish the brand image is the enterprise means of making use of traditional marketing skill. For example it can guide the consumer to land enterprise website by a better way. When the brand image is built up the network marketing then can make use of its cheaper price and provide immediately detailed data to customers. And it can well develop its function when the consumer would like to understand the special feature of product by landing the enterprise website.

117.3.2 The Network Marketing is the Key Point of Enterprise Marketing Work

In the enterprise electronic commerce development process if the traditional marketing has already extensively developed the network marketing should particularly be a key point of current enterprise marketing works. After the enterprise makes use of traditional marketing skill to create a higher customer click rate for the network marketing the enterprise can make use of network marketing to carry out the strategic target of enterprise marketing.

The network marketing of electronic commerce being effective should have three characteristics as follows:

1. *Higher additional value*

The so-called high additional value means when the customer lands the enterprise website, can not only acquire concerning information, such as product and company brief introduction etc., but also acquire the various related knowledge and other information of product.

2. *Characteristic*

So-called characteristic website means that the public's medium of traditional spread way is varied into spreading of personal way. The characteristic of network marketing was that the enterprise to understand the consumer's need and variety to provide the condition at any time. The customs can give their needs. The enterprise can product the products according to the needs which is provided by customers. These processes can be done by the network and network marketing for example.

3. *Interaction*

So-called interactions mean that enterprise's network advertisement that the usage of website should have the interaction process. Seeing from the standpoint of customer the marketing spread and the interactive advertisement on the network has two characteristics. One is that person need to provide the information and allow the advertisement to be subjected to many choices advertisement contents. The other is that interactive advertisement allows the different consumer chooses different advertisement information to satisfy personal demand of information.

117.4 Conclusions

This paper gave the method for improving the ability of innovation of electronic commerce on management. The paper proposed the method and measure on the management and establishment and implementation customer relation management in electronic commerce is debated. The method on human resource for electronic commerce is proposed. In the production the changing the mode of production to satisfy customer's need is given. Then the traditional marketing and network marketing is proposed for the electronic. The future works for electronic for management is to form the regulation for enterprise to do.

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Chapter 118
The Effect of Brand Image on Online Service Failure: Basing on Mainland China Online Retailing

Jun-feng Liao and Lin-lin Zhong

Abstract The research focuses on the issue of service failures in online shops, and moderate effect of brand image on customer repurchase intention. This paper integrates the theories of service failure, perceived service quality and other related theories, proposes the concept of perceived service failure, and study how online retailer's brand image affect customer repurchase intention after service failure.

Keywords Online service failure · SERVQUAL · Repurchase

118.1 The Posing of Questions

According to 2010–2011 the Study of China's Online Shopping User Behavior by IResearch, more than half of Chinese users have been dissatisfied with the online shopping experience in 2010. This shows that online service failure is widespread presents a growing tendency. Online service failure will lead to consumes' negative emotions and running off. Developing new customers and maintaining old customers are the issues that the site needs to concern in the fierce competition. It is difficult and costly to develop new customers. Therefore, it is valuable and significant to developing repurchase customer.

With the intense competition of E-commerce, races among online retailers are not limited on technology, product and service but upgraded to soft power such as brand image, customer relationships and so on. Brand image is the overall

J. Liao (✉) · L. Zhong
School of Economics and Commerce, South China University of Technology, Guangzhou, China
e-mail: ljf@scut.edu.cn

L. Zhong
e-mail: zllzippies@gmail.com

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perception to a brand that customers hold, it's a key factor of brand equity (Fan and Chen 2002). Park et al. (1986) point out that brand image communication to the target market has always been regarded as an important activity of marketing. Disseminating a well-defined brand can help enterprise to distinguish itself from competitors (Reynolds and Gutman 1984). A good brand image can decrease customers' selection risk, establish confidence to purchase and help to foster the identity of the enterprise. Many scholars have found that brand image have great impact on customer purchase behavior, but the studies of its effects on service failure are very few.

118.2 Literature Review

118.2.1 Customer Reponse following Online Service Failure

Forbes et al. (2005) found that after experiencing a service failure, the online consumer repurchase intention will reduce regardless of what kind of service recovery they took. Harris et al. (2006) compared online consumers' responses to service recovery with traditional ones. The results showed that the satisfaction of online consumer is higher than that in the traditional areas under the situation of low level service recovery. Taiwan scholars Kuo et al. act (2011) studied service failure and recovery in online auction and found that no matter what kinds of recovery the company took, it is difficult to increase consumer repurchase intention.

118.2.2 Brand Image

Brand image is the overall perception to a brand that customers hold, it is a key factor of brand equity (Fan and Chen 2002). Previous studies about brand image discuss its impact on customer purchasing behavior and customer loyalty. Derbaix (1983) points out that customer will purchase products with higher reputation as a strategy of reducing risk. Degeratu et al. (1999) found that customers' online brand loyalty is higher than that of traditional ones. Huang and Lin (2009) studied the relationship of organic rice brand image and customer perceived risk, and found that the higher the brand image, the lower risk customer perceived.

Most of the previous studies focus on the definition and classification of the service failure itself. Research on service failure can be supplemented in the following aspects: after experiencing service failure, consumer will have a perception about the service failure. On the research of customer perception and behavior, most scholars sought reasons from failure itself. During the process of service delivery, there are other factors may have impact on customer perception. Further discussion on this aspect is meaningful. Previous studies have shown that brand image significantly affect customer purchase intention and customer loyalty. How brand image affect customer perception and behavior after service failure?

118.3 Research Design

118.3.1 Variable Select

This study is to use SEM in quantitative study. Basing on previous researches and combining many studies, this theme is to set 7 variables as follow: Perceived service failure, perceived loss, perceived service quality, trust, and satisfaction, repurchase intention, brand image.

Liang (2006) believes that it belongs to service failure if the customer identified it regardless of whether service providers made that mistakes. This article proposed the concept of perceived service failure, measure it from the following three aspects: whether it's a failure or not, the severity of failure, how much responsibility the company should take. Gronroos (1984) pointed out that service failure will bring consumers 2 kinds of loss: economic loss and emotional loss. Xin and Bo (2006) divided it into economic loss and social loss. Ou and Sia (2009) thought that e-commerce trust is the consumers' expectation of an acceptable way of transaction take by the seller and able to fulfill the promised goods and services. Hempel (1977) believes that customer satisfaction is the result of consistency of "expected service performance" with "actual service performance". Jones and Suh (2000) points out that repurchase intention is the willingness that consumer will still buy the products next time after they used it. Derbaix (1983) points out that customer will purchase products with higher reputation as a strategy of reducing risk. Degeratu et al. (1999) found that customers' online brand loyalty is higher than that of traditional ones.

118.3.2 Hypotheses

- H1 Perceived Service failure and perceived loss are positive correlation;
- H2 Perceived loss and perceived service quality are negative correlation;
- H3 Perceived loss and satisfaction are negative correlation;
- H4 Perceived loss and trust are negative correlation;
- H5 Perceived service quality and satisfaction are positive correlation;
- H6 Perceived service quality and trust are positive correlation;
- H7 Satisfaction and trust are positive correlation;
- H8 Satisfaction and repurchase intention are positive correlation;
- H9 Trust and repurchase intention are positive correlation;
- H10 Brand image has a moderate effect on customer perception and behavior (Fig. 118.1).

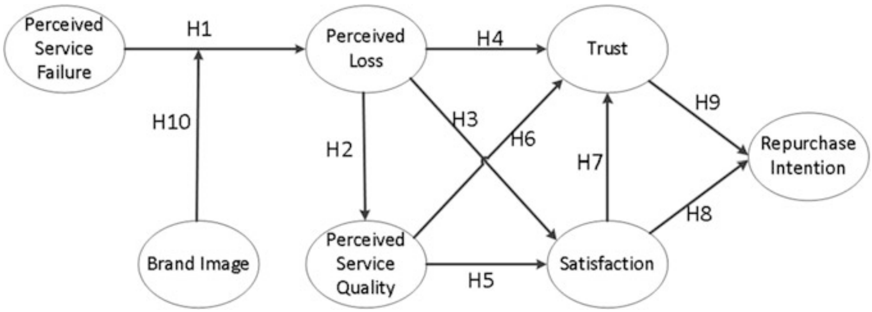

Fig. 118.1 Research model

118.4 Investigation Design

118.4.1 Tentative Investigation

Initial questionnaire has been finished basing on previous study and opinion by concerned experts. Questionnaires were sent to students of Bachelor degree and Master degree in Guangzhou, Shenzhen and SCUT. 179 effective questionnaires were recycled. The credibility and validity of this investigation matched with identification index. Meanwhile, according to feedback, some exposition modes have been changed to gain a formal questionnaire finally.

118.4.2 Formal Investigation

Formal investigation is sampling survey in enterprise, commercial district and college in Guangzhou and Shenzhen. 850 questionnaires have been sent and 784 were recycled. 732 of them are effective with 86.11 % effective rate. Ineffective questionnaire index contains: 1, unfinished, 2, more than 80 % of the answers are the same. Among all the samples, both male are 315 taking 43 % of them and female are 417 taking 57 % of the total amounts. 427 of them are students, taking 58 %. 305 of them are employees, taking 42 %. Most of investigators are among 18–35, taking 94 % of the investigators. 87 % of them have income among 1,500–3,000 per month. Comparing with reports by many Authoritative organizations, the sample-feature is considered to be reasonable.

118.4.3 Reliability and Validity

Basing on the reliability and validity analysis with SPSS 16, the result shows that Cronbachpsα is between 0.837 and 0.955. The entire Cronbachpsα is 0.911, so that the questionnaires have a good reliability and reasonable design. This theme used SPSS 16.0 to analyze the validity of samples. The result is as follow: KMO is among 0.703–0.817 and the entire KMO has reached 0.908. And Bartlett's statistical value is lower than 0.001, which means the hypothesis for sphericity was refused. It also means this data has a very high degree of correlation so it is fit for factor analysis.

118.4.4 Structural Equation Model Testing

This theme use AMOS 17.0 to test the hypothesis. The result of AFI, IFI and PFI are all match up with index. It shows that the model has good fitting effect and can do the following analysis (Table 118.1).

118.4.5 Path Analysis

As Table 118.2 shows, in those 9 hypotheses, 8 of them are supported for they are in significant level, but H2 is refused for not being significant.

Since H2 is not significant, eliminate H2 to get the modified model.

118.4.6 The Moderate Effect of Brand Image

As Fig. 118.2 shows, in group high brand image, among 8 hypotheses of the modified model, 7 of them are supported for they are in significant level, but H3 is refused for not being significant.

Table 118.1 Results of structural equation model testing

	Model fit standard	Ideal result	Model	Degree of compliance
AFI	X^2/df	<2.00	1.950	Yes
	RMSEA	<0.05	0.035	Yes
	GFI	>0.90	0.966	Yes
	AGFI	>0.90	0.950	Yes
IFI	NFI	>0.90	0.982	Yes
	TLI	>0.90	0.988	Yes
	CFI	>0.90	0.991	Yes
	IFI	>0.90	0.991	Yes
	RFI	>0.90	0.975	Yes
PFI	PNFI	>0.50	0.723	Yes
	PGFI	>0.50	0.644	Yes
	PCFI	>0.50	0.730	Yes
	CN	>200	476	Yes

Table 118.2 Results of structural models

Paths	Hypothesis	Estimate	Results
PSF→PL	H1	0.549***	Support
PL→PSQ	H2	0.083	Not Support
PL→SA	H3	−0.155***	Support
PL→TR	H4	−0.179***	Support
PSQ→SA	H5	0.846***	Support
PSQ→TR	H6	0.340***	Support
SA→TR	H7	0.639***	Support
SA→RI	H8	0.335***	Support
TR→RI	H9	0.613***	Support

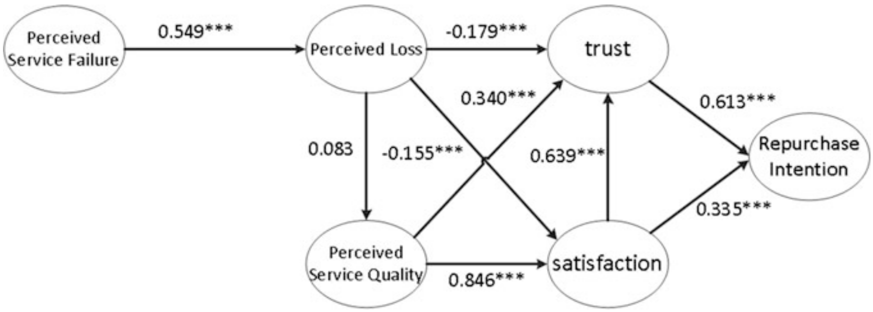

Fig. 118.2 Model testing result

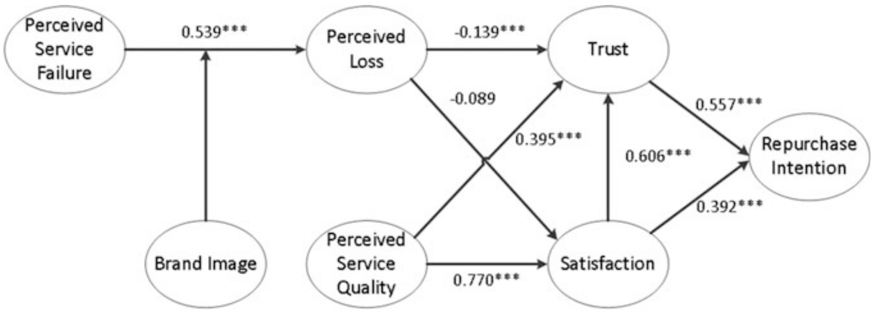

Fig. 118.3 Model testing of group high brand image

As Fig. 118.3 shows, in group of low brand image, all of the 8 hypotheses of the modified model are supported for they are in significant level (Fig. 118.4, Table 118.3).

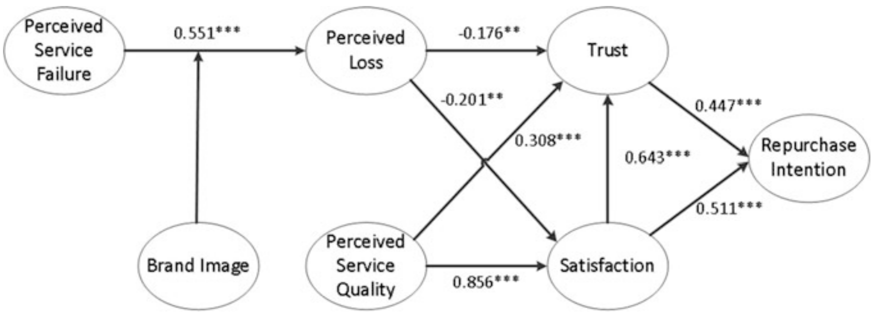

Fig. 118.4 Model testing of group low brand image

Table 118.3 Comparison of Path Analysis Results

	High brand image	Low brand image
H1 PSF→PL	Support	Support
H2 PL→SA	Not support	Support
H3 PL→TR	Support	Support
H4 PSQ→SA	Support	Support
H5 PSQ→TR	Support	Support
H6 SA→TR	Support	Support
H7 SA→RI	Support	Support
H8 TR→RI	Support	Support

118.5 Conclusion and Suggestion

According to the testing models, the conclusions have confirmed most of hypothesized. But H2 did not reach significance level. The reason will possibly be that customers' evaluation of online retailers' service quality tend to be rational and objective and are not likely affected by the negative emotions of perceived loss, this can be also reflected from the higher mean that perceived service quality presents. Most consumers believes that the failure is occasional and infrequent and will not greatly affect their evaluation of the quality of web services.

H1 is high in significance and path coefficient. This shows that consumers have perceptions about failure. And each person's perceived failure is not on the same level.

H3 and H4 are high in significance and path coefficient. It can be seen that even if perceived loss does not affect the customers' evaluation of the service quality of online retailers, it will affect their emotional behaviors and risk judgments to online retailers.

The significance of H5 is prominent. This result corresponds with the view of Brady and Cronin that service quality is a front variable of customer satisfaction. The higher service quality customer perceives the higher degree of satisfaction.

The significance of H6 is also outstanding. Thus, the improvement of service quality will win the trust of its customers.

The significance of H7, H8 and H9 are also outstanding and the path coefficient level also proves the significance of these assumptions. Satisfaction has great effect on trust and repurchase intention in e-commerce environment. And trust also plays an important role in the customer repurchase intention.

H10 is verified in the research. Comparing the results of group high brand image and group low brand image, group high brand image presents significantly higher mean than low brand image in the following sectors: perceived service quality, satisfaction, trust and repurchase intention. It can be seen that good brand image can ease the negative effect of service failure.

H3 is refused in group high brand image for it did not reach significance level while all hypotheses are supported in group low brand image. Therefore, in group high brand image, customer satisfaction do not greatly influence by perceived loss but by brand image. Brand image is customer's overall perception and subjective view to a brand. For a good brand image, most customers have established positive view to it and believe that enterprise with good brand image will have satisfactory service quality.

The results show that brand image can greatly ease the negative effect of service failure. Brand image is not only a symbol, but more a reflection of corporate culture to customers. Good brand image represents enterprise's reputation and their commitment. With an increasing number of online retailers spring up, enterprise should strengthen brand building, implement extensive publicity and promotion for a long-term development.

Firstly, online retailer should improve their service quality. Take strict control and pay attention to details from pre-sales to after-sales and from hardware facilities to software system, provide excellent service to customers, enhance customers' identification to the brand.

Next, it is important for online retailers to build up their own brand personality to distinguish themselves from other competitors. Online retailers should analyze target customers' characteristic and demand to implement brand positioning and establish value proposition.

Finally, online retailers can take full advantage of advertisement, press, public relations, blog and virtual community to integrate online and offline promotion, and multi-channel disseminate enterprise's brand personality and philosophy to impress customers.

Research has shown that effective service recovery can improve the customers' loyalty after experience service failure and create a good corporate image at the same time. Therefore, it is significance for enterprise to predict the service recovery and management. When the inevitable emergence of web service failure, the website should analyze the reasons for service failure and initiative to seek customer feedback, focus on the customer's mood and expectations of service recovery so as to timely, rapid, targeted for service recovery. In addition, website should learn the lessons from the error again and again, establish and improve the service failure and service recovery management system.

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Chapter 119
The Study of Knowledge Management in Chinese Enterprises Overseas M&As

Jia-kang Wang, Xue-meng Guo and Hong-chang Li

Abstract In the era of knowledge economy, knowledge management has become an important part of the core competitiveness of multinational corporations (MNCS).The Chinese enterprises go abroad for overseas mergers and acquisitions (M&As) inevitably involving two or more different cultures. In this context, the study of knowledge management with Chinese characteristics not only has important theoretical values but also has important practical significance. This paper firstly reviews the definition of knowledge management and M&As; secondly, this paper points out that it is necessity and urgency to implement knowledge management in MNCS; thirdly, this paper analyzes the factors affecting the knowledge management from four aspects: the characteristics of knowledge, the transfer side of knowledge, the recipient of knowledge and the transfer channels of knowledge; finally, this paper puts forward some proposals to the knowledge management of Chinese enterprises in overseas M&As.

Keywords Influencing factors · Knowledge management · Mergers and acquisitions · Multinational corporations · Strategy

119.1 Introduction

119.1.1 The Definition of Knowledge Management

Different scholars from different perspectives give different definitions of knowledge management.

J. Wang (✉) · X. Guo · H. Li
School of Economic and Management, Beijing Jiaotong University,
Beijing, China
e-mail: wjksunny@126.com

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Wiig (1997): the overall purpose of knowledge management is to maximize the enterprise's knowledge-related effectiveness and returns from its knowledge assets and to renew them constantly. Knowledge management is to understand, focus on, and manage systematic, explicit, and deliberate knowledge building, renewal, and application—that is, manage effective knowledge processes (EKP)

Saffady (1998): the systematic, effective management and utilization of an organization's knowledge resources.

Carayannis (1993): knowledge management can be viewed as a socio technical system of tacit and explicit business policies and practices.

Summing up the above point of views, this article believe that knowledge management comprises a range of strategies and practices used in an organization to identify, create, represent, distribute, and enable adoption of insights and experiences. Such insights and experiences comprise knowledge, embodied in individuals, groups or teams of the organization as processes or practices.

Generally speaking, knowledge can be divided into two categories: tacit knowledge and explicit knowledge. So knowledge management is divided into explicit knowledge management and tacit knowledge management. Explicit knowledge (also known as obvious or coding knowledge) is that people can get through oral, textbooks, reference materials, periodicals, magazines, patent documents, audiovisual media, software and databases. It also can be spread through the encoding of language, books, text, database etc. and it is easy to learn. Its management is relatively simple. However, tacit knowledge is difficult to be described by the way of the text. It often exists in human brain and in the manual skill. It is represented by human behaviors. Tacit knowledge includes the aspects of human's values, beliefs, foresight, experiences, skills, abilities etc. Judging from this angle, tacit knowledge contains cultural factors, emotional factors and cognitive factors. It is the invisible wealth of knowledge. Its management is relatively complex.

119.1.2 The Definition of M&As

M&As generally refers to mergers and acquisitions. Mergers refer to the combination of two or more independent companies into a single company. The dominant company usually absorbs other companies. Acquisitions refers to a company buy the stock or assets of another company by the way of cash or securities for the purpose of obtaining all or part of the ownership of the company.

119.2 The Necessity of Knowledge Management for Chinese Enterprises' Overseas M&As

119.2.1 It May Lead to Collaborative Human Capital Blocked and the Loss of Core Human Capital

Human capital refers to workers by investment in education, training, practical experience, health and other aspects so as to acquiring the accumulation of knowledge and skills, also known as "non-material capital". The owner has such knowledge and skills can bring extra wage earnings. It forms a specific capital—human capital. Human capital has a greater value-added space and appreciation potential than physical capital or monetary capital, especially in the post-industrial period and in the early knowledge economy period. Tacit knowledge is a vital part of human capital. Such as knowledge and skills owned by the employees. It attached to individual employees by the way of potential and not encoded form (Zhong and Xu 2007).

However, The people who owned company's key technology and customer resource may leave the company because of the difference education, culture background, business philosophy between China and other countries, and patriotic complex of the host country staff, resistant emotion to M&As brought by the unequal status, distrust of the new manager dispatched by China company, the inappropriate human arrangements and incentive programs, etc. This will cause an inestimable impact on company.

119.2.2 It May Cause the Loss of Customer Capital

Customer capital is an important part of the enterprise intellectual capital, refers to the value of organizational relationships between enterprise and its business partners. It is the possibility to maintain relationships between customers and enterprises.

Generally speaking, customer database, marketing channels, enterprise reputation, the quality of the service and customer loyalty is the basis of customer capital. It is the right way to achieve the enterprise market value. Functions of management must be subordinate to the enterprise values. Regardless of what values the enterprise follows, the value of the enterprise must ultimately be achieved through customer. Customers are not only the source of profit but also the carrier of enterprise's social responsibility.

On one hand, enterprise is prone to neglect the original customer's implied needs in M&As, and their cooperative relationship is not timely established. The relationship is unstable.

On the other hand, existing customers may interrupt the original relationship of cooperation due to enterprise's potential strategic adjustment. At this time competitors will squeeze the market. Therefore, the continuity of the relationship of mutual trust between the customer and the enterprise has important strategic significance.

119.2.3 It May Cause the Loss of Enterprise Brand Equity

Brand equity is associated with the brand, brand name and logo which can increase or decrease the value of products or services. It includes changing market share, profit margins, consumer recognition of logos and other visual elements, brand language associations made by consumers, consumers' perceptions of quality and other proprietary assets (e.g. trademarks, patents, channel relationships, etc.).It provides value to consumers and companies through a variety of ways. Brand capital is an important part of the implicit market capitalization. Under normal circumstances, M & As can greatly increase the economic benefits of the acquired company by the effect of brand advantage.

However, in reality, the expansionary effect of the brand has not been well implemented. A lot of brand equity has shrunk. If the acquired company in terms of its technical level and quality assurance system cannot guarantee the quality of the brand, the effect of the expansion of the brand become a negative effect. If the correlation degree of both products is not significant, the possibility of synergistic is very small, because in the field of non-association, the technology and cultural superiority behind the brand is difficult to transfer (Jiang and Yang 2007).

119.2.4 It May Cause the Loss of Tacit Knowledge Embedded in the Supply Chain

The nature of the supply chain is a learning system containing acquisition, sharing and use of knowledge. The stock and structure of knowledge is the decisive factor of corporate performance in the supply chain. The competition of modern enterprises is the competition between the supply chain and supply chain, the core knowledge and capacity of the supply chain is the source of long-term competitive advantage, and this long-term competitive advantage is endogenous.

After M&As, many companies are not timely to re-optimize the supply chain from a global perspective. It lead to supply and demand network of raw material suppliers, manufacturers, wholesalers, retailers and ultimately consumers in the production and circulation lack of coordination, resulting in a huge loss of tacit organizational capital (Chen and Xue 2005).

119.2.5 The Different Accounting Standards

Accounting standards is the objective needs of the market economy development. The content of the accounting standards are different due to different political, economic and legal system between China and other countries.

As a developing country, China's capital markets are developing, the legal system needs to be perfect. Although in the building of Chinese accounting standards system China learn more from the international practice, but still in the adopted scope of the fair value, the accounting treatment of business combinations, accounting treatment of impairment of assets, disclosure of related party relationships and transactions, government subsidies and several other aspects are quite different with the international accounting standards. Thus, it objectively requires that the business-related personnel must be familiar with China Accounting Standards and the International Accounting Standards. Therefore, accounting information disclosed are in line with domestic and international legal requirements (Feng 2001; Tian and Gao 2006).

119.3 The Influencing Factors of Knowledge Management in Chinese Enterprise in Overseas M&As

In order to study the factors affecting knowledge management, we should know the relationship between the explicit knowledge and the tacit knowledge. We also should study its communication process.

Knowledge that flows, by being shared, acquired and exchanged, generates new knowledge. Existing tacit knowledge can be expanded through its socialization in communities of interest and of practice, and new tacit knowledge can be generated through the internalization of explicit knowledge by learning and training. New explicit knowledge can be generated through the externalization of tacit knowledge, for instance, when new best practices are selected among the informal work practices of an organization. Existing explicit knowledge can be combined to support problem-solving and decision-making, for instance through the application of data mining techniques to identify meaningful data relationships inside corporate databases. These four different phases of the knowledge life-cycle—socialization, internalization, externalization and combination—have been formalized by Nonaka and Takeuchi in the diagram in Fig. 119.1. Under this view, "knowledge management" can be explained as the management of the environment that makes knowledge flow through all the different phases of its life-cycle (Borghoff and Pareschi 1997).

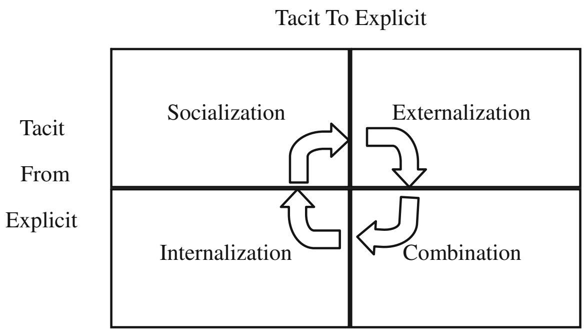

Fig. 119.1 Knowledge conversion as proposed by Nonaka and Takeuchi

119.3.1 The Characteristics of Knowledge

Kogut and Zander (1993) have studied the relationship between the characteristics of multinational internal knowledge and the choice of knowledge transfer mode. The results show that: The more complex of the knowledge is, the more difficult to encode the technology is, and it is more difficult to disseminate the knowledge (Kogut ands Zander 1993).

Simonin's Empirical method proved that the reason of ambiguity knowledge is caused by the tacit, asset specificity, complexity, experience, partner protectiveness, cultural distance and organizational distance. He thinks the main reason of the ambiguity knowledge is the tacit. The higher the degree of tacit knowledge, the higher the degree of fuzziness of the knowledge, thus, it is more difficult to transfer knowledge (Chen 2002; Gupta 2000).

119.3.2 The Transfer Side of Knowledge

Usually, the transfer of knowledge is bidirectional in multinational. That is the transfer of corporate strategy and corporate values from the parent company to the subsidiaries of host country and the transfer of know-how, proprietary culture, and proprietary business philosophy from the subsidiaries of host country to the parent company. The influencing factors of knowledge transfer are the willingness of the sender's and the value of the knowledge. The willingness of knowledge transfer from the parent company to the subsidiaries of host country is related to the subsidiary's strategic position and the relationship between the parent company and the subsidiaries. The higher the strategic position of the subsidiary is the stronger willingness of knowledge transfer from the parent company is.

However, the willingness of knowledge transfer from the subsidiaries of host country to the parent company is related to the value of the knowledge. The higher the value of proprietary knowledge is, the more difficult to transfer it from a subsidiary of host country to the parent company.

119.3.3 The Recipient of Knowledge

Szulanski (1996) thinks learning and absorptive capacity are the important factors for success of knowledge transfer.

Zahra and George (2000) thinks past literature reveals company's absorptive capacity from acquisition (Zahra and George 2000; Kim 1998; Lane and Lubatkiu 1998), digestion (Dodgson 1993), conversion and use of the knowledge (Nonaka 1994; Leonard-Barton 1995).Knowledge transfer success in person is decided by the willingness to learn, ability to learn and existing knowledge structure.

Hamel (1991) proposed the willingness of joint venture partner to learn the skills of other partners is the decisive factor in knowledge learning.The stronger the subsidiary's learning ability is, the better the effect of knowledge transfer will be. If the structure of existing knowledge and receiving knowledge are similar, the knowledge will transfer easily.

119.3.4 The Transfer Channels of Knowledge

Knowledge can transfer from one organization to another organization through many channels. The most common is through the transfer of personnel, technology and organizational structure to the recipient organization, or by changing the personnel of the receiving organization, technology or organizational structure to achieve knowledge (Argote 1999).

The amount of knowledge transfer channels will obviously affect the quality of knowledge transfer. The more channels are, the more stimulation subject to the same kind of information in different ways will be, and thus the knowledge is more likely to be accepted.

119.4 Recommendations

119.4.1 Build a People-Centered and Inclusive Corporate Culture

Chinese enterprises' overseas M&As is related to two or more completely different cultures. The corporate culture is the embodiment of the competitiveness of enterprises and it is the basis of the knowledge management. It not only includes the organization's expectation for the members, but also contains the members' expectation for the organization. To speed up the dissemination and sharing of the tacit knowledge between the parent company and its subsidiaries, we must build people-centered, inclusive corporate culture. People-oriented corporate culture refers to the company's culture should be established upon the ability of human's, protect enthusiasm and creativity of their employees, and give full play to their ingenuity and pioneering spirit. So the company can discover talents, cultivate talents and make good use of talents. It continuously enhances the competitiveness and potential for further development of the company, better achieves management objectives, and accelerates the pace of health and overall corporate development of the company. The construction of people-centered and inclusive corporate culture requires that the enterprise and its managers should provide a good system and an effective competition mechanism (Liu and Ouyang 2005).

119.4.2 Construct an Incentive System

Multinational M&As may cause the increase of the number of employees, but it does not necessarily bring about company's performance improvement. Because parent company and its subsidiaries have their own unique resources, so knowledge-sharing is contrary to the behavior of maximizing the interests of the subsidiaries in a certain extent. Therefore, it is necessary to establish the mechanisms of motivation and authorization to encourage the enthusiasm and initiative of the staff in order to provide institutional guarantees for knowledge sharing and innovation. Maslow use the terms physiological, safety, belongingness and love, esteem, and self-actualization needs to describe the pattern that human motivations generally move through. The needs are different for different employee. Therefore, it requires the establishment of a wide range of incentive programs.

The incentives contain material rewards and spiritual rewards (Yang and Chen 2007).

The material rewards include salary, bonus, stock etc.

The spiritual rewards, such as to give the employees a full voice, to allow the employees to participate in the management and decision-making process involved in decision-making, to give the employees more responsibility, to provide a wealth of training and promotion opportunities for the employees, and to give the employees greater freedom and permissions are also necessary.

119.4.3 Establish a Learning Organization

Traditional enterprise's organizational structure is designed and implemented in accordance with the requirements of the rigid management. This design led to a lack of communication between different departments. It reduces the overall strength of the organization, and more importantly, it keeps focus on only immediate problems, while ignoring the long-term, fundamental, structural problems.

While learning organization motivates employees to learn, so as to continuously acquire and transfer knowledge resources. It advocates the multi-feedback and open learning, so as to form of a shared and interactive atmosphere in the organization. It gives full play to the high efficiency of the knowledge team. The structure of the organization does the conditions for sharing of the tacit knowledge. It will form a common vision of the staff through regular training, communicating and learning activities. It will promote the exchange and dissemination of knowledge through the establishment of appropriate organizational culture (Wang et al. 2010).

119.4.4 Appoint the Chief Knowledge Officers

In many organizations, a new position has emerged in recent years that will significantly affect the knowledge management activities in the enterprise. The title of this position is the Chief Knowledge Officer (CKO). It refers to a company or internal administrative officials that responsible for knowledge management. The establishment of CKO is conducive to promoting the exchange and sharing of the tacit knowledge of business organization (Wang 2006).

His duty is to re-integration the scattered, isolated knowledge and information, to formulate a unified policy to constrain the organization's knowledge management activities, to establish and create the environment which can contribute to the accumulation and share of knowledge, to ensure the normal operation of the knowledge base facilities, to promote knowledge integration, knowledge production and knowledge-sharing process, to supervise and ensure the quality and style of the knowledge base consistent with the company's culture.

119.4.5 Change the Management Model

Knowledge becomes the core competitiveness of enterprises only if the knowledge is mastered by employees of the enterprise. After the merger is completed, enterprises must fundamentally change, rather than simply restructuring or "slimming". The company should break the traditional vertical, linear level management, and establish the flexible, knowledge-service-centric management model. The organizational structure should be changed from the traditional "pyramid" type of management model into a flat, team, and network management model. The flat management can accelerate the speed of transmitting information. It is conducive to the exchange of knowledge. It also can stimulate initiative and creativity of employees. Management team can contribute to the effective transfer of the knowledge, especially the tacit knowledge, and it can develop a sense of mutual trust between employees of the company. Company executives should be more concerned about the status of enterprises in the entire value network, and constantly adjust the enterprise development strategy. The executives should look for strategic resources to support the strategic objectives (Chu et al. 2006; Zhang 2005).

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Chapter 120
The Study on Innovative Talents Training Model Based on the Tacit Knowledge

Xue-fei Zhang, Hong-na Tian and Rong-lin Wang

Abstract Tacit knowledge is a kind of unexpressed knowledge. Compared with explicit knowledge, it possesses much more fundamental and innovative function. In teaching practice, knowledge dissemination should be involved with an effective combination of tacit knowledge and explicit knowledge. This article presents that the innovation of science is derived from tacit power, and it further displays the research of creative talents training model based on tacit knowledge.

Keywords Tacit knowledge · Explicit knowledge · Innovative talents · Tacit power · Innovative capacity

120.1 Contents of Tacit Knowledge Theory

Polanyi is a British philosopher who first proposed the concept of tacit knowledge in the book of "Individual Knowledge" in 1958. Polanyi argues that human knowledge could be divided into explicit knowledge and tacit knowledge. Explicit knowledge can be explained in language, words and symbols clearly. In contrast, tacit knowledge is a kind of knowledge widespread used, but we could not express it with language, words and symbols exactly, such as the knowledge we owned in the process of doing things. The key point of tacit knowledge theory is that we know more than we can explain (Zhang and Yu 2009).

X. Zhang (✉) · H. Tian · R. Wang
Harbin University of Science and Technology, Harbin, People's Republic of China
e-mail: zxf7738@sina.com

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120.2 The Role of Tacit Knowledge Theory in Teaching

The tacit knowledge theory changes teachers' traditional teaching concepts and brings them new understanding of the multiplicity of teaching process. The teaching process is not only a process of knowledge transmission and mastery, but also a direct experience process to realize and acquire tacit knowledge through practical activities. It is also a process which makes tacit knowledge to be explicit and symbolic, and thus enables tacit knowledge to be tested, revised and used (Wang 2008).

Tacit knowledge could bring some major benefits. To begin with, it is beneficial for reflecting students' subjectivity and teachers' leading role in the classroom teaching. Furthermore, it could provide students with time and space of cooperative and inquiry learning. Besides, tacit knowledge helps students strengthen the training of learning method. It encourages teachers to create and develop learning environment and enhances the relationship with students. Eventually, tacit knowledge benefits students to transform cognition, broaden vision, develop thinking and improve ability (Yi 2006).

120.3 The Innovation of Science is Rooted in Tacit Power

Compared with developed countries, domestic students have certain advantages in mastering systematic subject knowledge, but they lack of innovative and practical ability in that the major approach to acquire knowledge for Chinese students is reading books. Human knowledge could be divided into explicit knowledge and tacit knowledge according to its external degree. They are similar with the two parts of iceberg. The former is floating in the water, and the latter hold up the whole iceberg under water. Nevertheless, until now, many people do not realize the knowledge underwater, so that they ignore the tacit knowledge inadvertently. Practice has proved that skills could not be expressed by words, and scientific innovation originates from the power of tacit knowledge. Therefore, the tacit knowledge is the root and foundation of explicit knowledge development and human knowledge innovation. People could only learn and improve tacit knowledge through human practical activities experience (Jian 2005).

The core of innovation is that you have certain breakthrough and persist in a unique opinion. To illustrate, you create some new and valuable thoughts, opinion, method and product. In the process of innovative activities, innovation subject need to fully use their stock and structure of tacit knowledge in order to improve innovation capacity. It is difficult to describe tacit knowledge by language because it exits our daily detailed work. University teachers should use and share their own tacit knowledge with students to train innovative talents (Wei 2009).

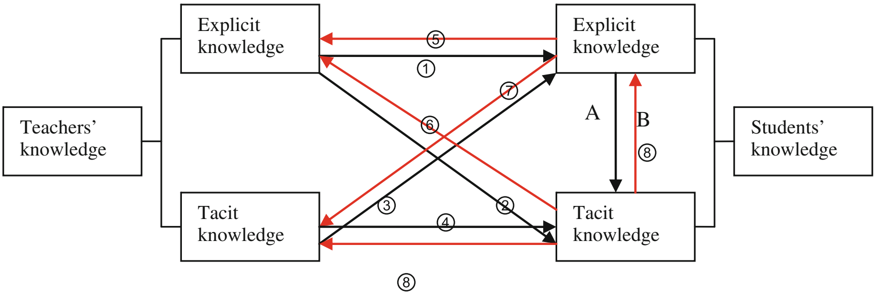

Fig. 120.1 Ideal knowledge transmission and promotion process

120.4 Innovative Talents Training Model Based on Tacit Knowledge

In the traditional teaching mode, related teaching material is the core content and tool for teachers to impart knowledge to students. The knowledge transmission process is shown in the Fig. 120.1. The whole process mainly contains explicit knowledge to explicit knowledge and explicit knowledge to tacit knowledge, but it overlooks the process of tacit knowledge to explicit knowledge and tacit knowledge to tacit knowledge which causes knowledge narrowing and losing (Tian 2009).

The innovative talents training model based on tacit knowledge should add two new approaches. First of all, students need to internalize the explicit knowledge into tacit knowledge. After students absorb explicit knowledge from teachers, they should understand and digest it by means of their own tacit knowledge in order to improve students' tacit knowledge accordingly. Secondly, we need to transform students' tacit knowledge into explicit knowledge. Students tend to actively express tacit knowledge in an explicit way after they obtain new explicit knowledge (Deng 2011).

There exists some deeper information in this knowledge transmission process. For example, students' explicit knowledge could improve teachers' explicit knowledge. Students' tacit knowledge affects teachers' explicit knowledge accumulation. On the other hand, students' explicit knowledge influences on teachers' tacit knowledge internalization. Students' tacit knowledge has effects on teachers' sense of tacit knowledge (Zhang and Yu 2009).

We believe that university education should shift original emphasis to outside of classroom and find some appropriate ways to enhance domestic students' practical ability and innovative capacity (Polanyi 1958). Recently, we could take some measures as followed:

120.4.1 Deliberating Tacit Knowledge and Observing Students' Tacit Knowledge

Firstly, teachers should constantly think about tacit knowledge, and they need to observe students' tacit knowledge as well. According to tacit knowledge theory, we must realize that students obtain knowledge not only depended on eyes, ears and good memory, but also relied on lots of tacit knowledge. Although tacit knowledge is not perfect and clear from view of explicit knowledge, it plays a basic guiding role for students' life and cognition. Consequently, teachers must consider their own tacit knowledge and explore the internal relations between teaching behavior and tacit knowledge. Also, teachers should strive to recognize and understand the complex effects of tacit knowledge on students learning behavior (Polanyi 1957).

120.4.2 Adding Practical Teaching

Moreover, university teaching reformation should start with balancing the practical and theoretical teaching. It is beneficial to develop case teaching in that case study enables students to absorb and dominate explicit and tacit knowledge naturally (Polanyi 1966).

120.4.3 Founding Scientific Community and Research Team to Promote Mentorship

Some experts argue that college students, especially postgraduates in certain academic field would involve two kinds of tacit knowledge. One is derived from long academic field experience which is a practical subconscious knowledge. The core of this tacit knowledge is the elites' capacity to regulate and publish scientific papers. Another tacit knowledge is obtained from research practice, such as intuition, imagination, research skills and cooperative competency. These examples prove the importance of tacit knowledge. We could indicate that closed mentorship is an effective dissemination format of tacit knowledge. Thus, university teaching reformation not only requires students to learn further academic theory knowledge, but also encourages students to join in scientific community and research team. It helps students learn tacit knowledge outside of classroom through contacting with professors and exports (Ferguson 1977).

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Chapter 121
Sports Marketing is a Weapon to Strengthen the Brand Value for Modern Enterprise

Peng-hui Liu and Li Gao

Abstract Marketing is an important means to build a modern enterprises brand but the sports marketing is the most important with its "viral" unique advantage and affect the enterprise brand development. The article uses the literature research method and logical analysis method and case analysis method and the establishment of brand and sports marketing mechanism model analyzed the sports marketing to corporate brand value of the weapon effect and the combination of sports marketing paradigm to summarize the operation of enterprises sports marketing success tips.

Keywords Sports marketing · Strengthen · Brand value · Enterprise

121.1 Introduction

The internationally renowned sporting events "viral effect" intensified in recent years. The Olympic Games and Asian Games and the Winter Olympics was successfully held and the sporting events achievements numerous of prominent figures and well-known commodities and well-known enterprises. This great marketing opportunity caused great concern in the domestic and foreign enterprises. They transferred their vision and marketing focus from the product itself to

Peng-hui Liu Doctoral Student Long Ren University South Korea.

P. Liu (✉)
PE School Beihua University, Jilin, China
e-mail: z7811232005@yahoo.com.cn

L. Gao
Qingbei Nine Years Schools, Piaohe Town Jiaohe, China

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a sporting event. They used sports events as a marketing platform to develop new markets and improve brand value. Thus increase their visibility. Well-known brands such as Coca-Cola, Samsung, Li-Ning, the brand had integrated products and sports tightly through in-depth analysis of the enterprise product content, and firmly seized every event opportunities to the international market successfully.

The huge power of sports marketing can play a role in fueling the development of enterprises. The first we will clear Sports marketing and corporate value of the product relationship. The second will use of this "weapon" for mutual promotion and common prosperity and the development. To better understand we will establish the relationship model and then conduct a detailed interpretation.

121.2 The Establishment of a Model

Before the model establish we will clear connotation of sports marketing. But Sports Marketing was a spread of enterprise products also long-term strategic means. Sports marketing belonged to the scope of marketing with a unique perspective on brand management and strengthening plays an important role (JinNian and Qiang 2006). Because it conforms the development of the human spirit civilization also follow the law of the operation of the market. The enterprises established a corporate image and promote their products and stimulate consumption through participation or sponsorship of sporting activities. Its effect had been recognized around the world. At the moment every enterprise wants to use sports events to increase their visibility (He and Liu 2006). Sports marketing mode of operation is placing in rapid changes. The enterprises can be used as a form of a commodity in order to form a complete sports industry. Of course, can use of a variety of sponsorship to the sport as the main for product promotion also.

Marketing can't be separated from consumers and products. Sport marketing was more inseparable from the sport. The relations that clear to consumers and product and sports are conducive to the establishment of the model. Modern marketing scholars for the understanding of the product beyond for physical products far and they had raised to a certain level of theory the product itself can not meet the enterprise development and would like to continue to progress through the brand. The brand can be regarded as product that created for many years also is a kind of corporate culture. The brand need the spirit that move forward and sport is more fully reflects the activities of human emotions. Because viewers had feel an upsurge of ups as the arena of intense competition thus the spirit of sport can be integrated into the spirit of the brand (Du 2008). The consumers can be seen as the god of corporate and their preferences changed may affect the direction of product development but also the impacted on sporting events to open up. The enterprises participated in sports competitions and into the consumers' leisure and culture through various forms of participation. The consumers were feeling the activities of the sports at the same time corporate were passing the brand message to "moistens everything silently" approach.

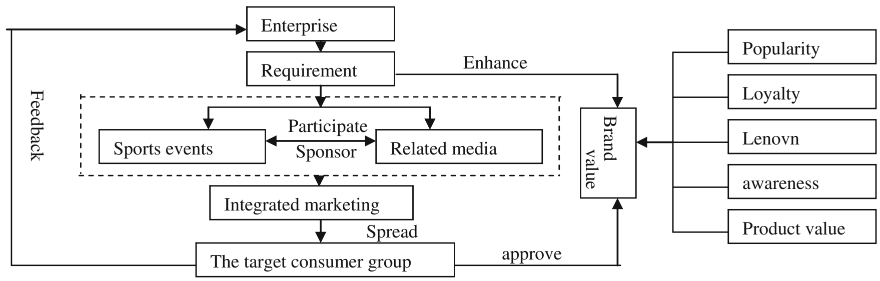

Fig. 121.1 The principle of sports marketing for corporate brand

We had cleared the relationship among consumers and products, and sports in order to establish the model of sports marketing to corporate brand. Shown on Fig. 121.1.

121.3 Interpretation of Three Elements of the Model

The elements were broad in model but it isn't difficult to seed the main line of their products and sports marketing and the target consumers group. Our first look an important element in at the model: brand value. Today, the consumers "recognized brand consumption" are prompting companies that must to conform the business trend of the time and improve brand value and display their marketing practices (Qiang and Si 2008). "Recognized brand consumption" requires companies to build products for the brand. The way was able to stand out in the fierce enterprises competition in the market. In order to pursue the development and changes in the market companies use a variety of marketing techniques and new ways. The enterprises study the marketing strategy but also to improve the product quality, and take into account the popularity of the brand awareness, consumer loyalty, the degree of association, as well as the inherent value. Modern consumers disgusted with the intuitive and hard advertisements very much. Thus good product isn't able to enter mind of the consumers. The enterprises of repeated publicity caused consumers antagonistic. Sports marketing catered to situation of consumers and influenced the spending habits of consumers and at last had became the highlights of brand marketing.

The core of elements of the model is the rational use of the sports marketing approach. The best sports marketing model is implantation marketing of sports media and implantation marketing of sports events.

There are three forms on implantation marketing of sports media commonly. The first, the supplies of media and journalists to participate in sporting events implanted which requires media journalists to use their products and implanted in the media to appear. For example: communications equipment, beverages, mineral water, casual wear and so on. The second, sports media column was implanted (Lu and Yang 2008). Most enterprises are on the title in the form of corporate image into the sports column. The third, through the sponsorship of the internationally renowned major sporting events live television broadcast or the purchase of broadcast media advertising time or directly sponsored by the media get good exposure and access to jointed interests.

Implanted marketing of sporting events was the focus of attention. Because it hadn't been by regional and country restrictions and extremely infectious and spreading had became a form of media the highest exposure. It appeared in this form that the title, sponsor and purchased related power. The title is the game naming or stadium naming. The game naming is through financial sponsorship to become the title sponsor and during game the specified name was mentioned many times. The stadium naming is a mode of sponsorship to stadium. They use their own business or product name to name. The products content of sponsored related or unrelated with events directly and designed the tournament or specified products or the sponsorship of the event providers. Such as sports apparel, shoes, hats, receiving awards, functional sports drinks, sports facilities were the designated product. Such as Haier air conditioning, phone, and the corresponding electronic equipment are unrelated to the product. This form that purchase of the powers is more common in today's sports events. Such as the event emblem, mascot, and souvenir production rights, use rights, exclusive rights to sell at a sporting events.

The consumers group of target is another important element. To be successful enterprises that study the target group of consumers and enhance brand value to suit the changing tastes of the target consumers groups necessarily from the model. The enterprise products production of marketable and gives life to product. The operation of the product life is by means of intense sporting events. The enterprises spread product information, values, culture, and the spirit to the consumers group of target (Yang and Dong 2007). So the consumers believe their products and track similarity to recognition and brand value in the race. The customers purchased products in the tournament if marketing was successful. Contrary if was failure that failure information went back to business and business solved this problem and re-market marketing.

121.4 Strengthening Effect of Sports Marketing for Brand Value of the Modern Enterprises

Strengthening effect of sports marketing for brand value of the modern enterprises can increase brand awareness, reputation, loyalty, the degree of association. Specific performance follows:

121.4.1 A Successful Sports Marketing Operation can Make Corporate Brand Awareness and Visibility to Improve More Quickly

Sports event marketing with consumers focus, speed of information dissemination, and wide publicity is better than other marketing methods. Mode of operation is relatively flexible. Something based on the static-based sports flat panel display. Such as outdoor advertising, the posters, exhibition card. More of them were based on dynamic use. Such as the sports media for the sponsor the title companies duplicate reports, the star group join and the star operational effect to the brand and the sport closely integrated. In Implanted of sports marketing the success of the 2008 Olympic Games can not let the world to forget that reflects Chinese people's wisdom, perseverance, never admit defeat, pioneering and enterprising spirit of the Olympic Games. The passion of interpretation in the opening ceremony had promoted the brand. Such as: unknown Shenzhen Jin Xiang technology companies had made LED screen of huge picture of a combination and people were shocked with attention the LED went into the international market. The company orders were four times than usual and become a big beneficiary of the Beijing Olympic Games.

121.4.2 A Successful Sports Marketing Operation Make it Easily to Maintain Consumers Brand Loyalty

Sports symbolize passion and vitality and more symbolizes the eternal confidence. The fierce competition of the players in the game conquered the audience's attention. Sports stars make the enterprise products to win enough popularity. Sporting events can provide rich experience platform with consumers. It combines entertainment and technical. It make enterprise brand into the consumers Line of sight also (Wu 2010). At the same time consumers are more enthusiastic about their products. Through scene experience the consumers feel the passion of sports events and the service of the enterprises brand and more the fun of sporting events. The consumers memorized brand and bind brand and formation of the consumers' desire in the fun and love of sports events. At last enterprises had realized the marketing effect of multiplier.

Li-Ning brand was known widely in China. "Anything is possible" is not only the slogan of the company's products but also business essence that was accumulated and perfected. The success of the enterprises can't be separated from sports marketing. The early they product production with gymnastics champion Li-Ning sports star effect to bigger and solid. The late through continuous sponsorship of major sporting events at home and abroad strengthened the brand and complement the market with multiple products. They increased the loyalty of the consumer product. Ultimately increase the loyalty of the consumers of the product.

121.4.3 Sports Marketing of Success Make More Rich to Association of Consumer Brands

The practice had proved that sports marketing effect is remarkable for the promotion of new products and the application of new technologies. The Sports Items has advantage with targeted, directly high attention. The products and technologies were presented vividly and created a sensational effect though sports events carried out public relations activities to riche the brand association. The consumers can't forget the World Cup football of passion and fanaticism. In the World Cup football beer play the role of the booster. During the World Cup major enterprises expanded promotional activities and they established the beer culture square and organized Cultural Festival of passion. So they made the people to feel the brand and rich brand association of the consumers more.

121.4.4 Brand Value is Enhanced to Achieve Easily

Now, more and more enterprises were willing to participate in sports events. From the awareness of enterprise brand to understand to well-known everything became easily. Sports marketing made of operation fitted with sports Items naturally. At last it eliminated the consumers' sense of exclusion. There are many such examples in reality. The rapid promotion of the brand value of Samsung was due to become the global sponsor of Top. Thus the image of the authority and professional and strength was shaped. Adidas also enhanced the value of the brand with the exclusive sponsor and the whole naming constantly. Li-Ning brand is more adept at using the event to enter the international market. Of course all of them will require that companies have long-term vision and strong financial strength and accurate judgment and professional team to study the development of the marketing.

121.5 Recommendation That Enterprises Successfully Carried out Sports Marketing

The enterprises should follow certain principles that can direct the direction of enterprises sports marketing in carrying out the sports marketing process.

121.5.1 To Enhance Compound Between Sports Activities With the Enterprise Brand to Better Combined

The new sports continue to emerge also content of numerous with the continuous progress of human society. Whether like it or not and can not participate but are real.

Don't shift in individual ideas. Sports marketing sphere of influence is relatively limited. It is by means of sports but must be based on enterprise products. We fund the point of the integration of sports from the overall interests of the enterprise. Sports marketing can't be carried out If you put aside their products. If you put aside the sports marketing that sport can't be tailored for the enterprise products. The enterprises faced the target customer groups that they are the modern young man with a vibrant and adventurous and stimulate and personality (Wang 2010). The enterprises must maintain consistent at their position and enhance their compound in order to allow consumers to receive and maximize the effect of sports marketing.

121.5.2 *Sports Culture Strengthens Corporate Culture for the Strong Corporate Brand*

Sports activities and the enterprises products are mostly belong to a rigid combination. If use the results of a little awkward directly and ineffective and marketing flawed appeared. However, if the sports culture and corporate culture is created a way for consumers to accept the emotional is a very effective for powerful corporate brand. In the sports arena the people can be immersive to watch, feel and sports activities to bring people's passion and positive hard work and enterprising spirit which has become the sports activities germination of the spirit of sport. The enterprises had fund out the relevant points between the products with this spirit of the enterprise or sports image so enterprises will be able to integrate the sports culture into brand association. Between the consumers with the brand resonate and sports culture that strengthen the corporate culture shape a strong corporate brand ultimately.

121.5.3 *Comprehensive use Various Marketing Techniques and Resources, Comprehensive Planning of Marketing Activities*

As we have made it that the diversity of sports marketing clearly but must integrate other marketing tactics to achieve the best marketing results. Simple a marketing product or sports activities can not be fully integrated. Sports marketing were systems engineering of complex and continuous and it is process of mental activity to the formation of the stigma of corporate brand in the minds of consumers. We would choose the sports marketing as a propaganda tool of the brand. It is necessary that meticulous planning and efforts to make the product stand out and became bright spot. To use unique performance techniques and strategies to attract customers to build a strong brand positioning to promote their products.

The enterprises have chosen celebrity endorsements the a common approach but the choice of general athletes is a via too. If companies choose was accurately to be able to make the enterprise with minimal costs to the maximum commercial value (Dong 2010).

121.5.4 Focus on the Long-Term Interests of the Enterprise to Develop Continuous Investment Plans, and Identify the Different Stages of Production Standards, and Assessment and Improvement

Marketing effectiveness is a difference between sports marketing from other marketing. The general marketing carried out by means of marketing to promote product sales to increase market share and achieve immediate results in a short time but that is “flash in the pan”. However sports marketing can’t achieve this effect in a short time. It requires the enterprises have a keen sense of perspective and insight. As well as confidence and courage of long-term, sustained investment. Only follow-up product promotion passed product information and corporate culture to the target consumers group, otherwise that was a waste of resources (Ma 2010). The enterprises spent a lot of manpower, financial and material resources and hoped to get the expected returns in the creation of brand in order to correctness and validity of assess investment. Therefore, the enterprises need to establish a clear and phase standard to assess the sports marketing activities, to realize the objectives of the enterprise gradually. As a beautiful vase firing is not easy, it is long-term and very difficult to remain intact

121.6 Conclusion

1. Sports marketing have to study consumer behavior and value orientation with other marketing practices in common. We have to understand the role of sports marketing to corporate brand correctly. Do not swarmed.
2. The operation of the form of sports marketing is varied. The enterprises have to weigh each method and its application fully and combine their characteristics to be utilized in order to achieve sponsorship of maximize efficiency.
3. Sport marketing is not a “magic bullet”. Although there are many successful examples but most companies are not the real return on invested heavily in a short period of time. Therefore, to keep in mind that sports marketing is a system engineering and long-term planning and operation. We must have patience enough.

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Chapter 122
A Solution Procedure for the Capacitated Vehicle Routing Problem with Three-Dimensional Loading Constraints in Online Supermarket Delivery

Min-fang Huang and Yuan-kai Zhang

Abstract Due to the very large number of online supermarket's orders, it is necessary to consider loading constraints of the packages while arranging vehicle schemes. It is expected to greatly improve the loading rate and reduce distribution costs. Aiming at the delivery problem from supermarket's distribution center to the delivery stations, this paper studies the three dimensional loading constrained vehicle routing problem. First of all, according to the actual conditions of packing problem, it designs heuristic rules for packing activity and calculation formulation for residual loading capacity, based on which a three dimensional loading is proposed. Combined with the loading algorithm, it then presents the initial vehicle scheme generation measure and designs optimization method of schemes. Finally, it constructs an experimental example to validate the proposed solution procedure. The result shows the validity of the procedure for vehicle routing problem with loading constraints of large number of packages.

Keywords Heuristic algorithm · Online supermarket · Three-dimensional loading · Vehicle routing problem

122.1 Introduction

In recent years, online supermarket has become a new trend of e-commerce transactions. Unfortunately, most of the attempts in the world have failed, for example, Webvan, Streamline, HomeGrocer. Experts have realized that the high

M. Huang (✉) · Y. Zhang
North China Electric Power University, Beijing 102206, China
e-mail: hmf1006@126.com

Y. Zhang
e-mail: ykzhang6635@gmail.com

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distribution cost has been the primary cause. Due to the very large number of online supermarket' orders, it is necessary to consider loading constraints of the packages while arranging vehicle schemes. It is expected to greatly improve the loading rate, as well as reduce distribution costs. Based on some survey results, online supermarkets always sale the most frequently used daily goods. According to the characteristics of the sold items, their delivery problems with loading constraints fall into the category of the capacitated vehicle routing problems with three-dimensional loading constraints.

Capacitated vehicle routing problem with three-dimensional loading constraints (3L-CVRP) (Tao and Wang 2010) has important theoretical significance and practical application value. Several effective meta-heuristic methods for the capacitated vehicle routing problem (CVRP) were recently developed by Baldacci et al. (2010, 2011). 3D bin packing problem (3D-BPP) is relevant for solving 3L-CVRP. Exact methods for 3D-BPP were proposed by Martello et al. (2007) while heuristic methods for the 3D-BPP were developed by Crainic et al. (2008). Procedures for 3L-CVRP often result as enhancements of 2L-CVRP procedures. Several algorithms for the 2D case were proposed by Fuellerer et al. (2009), Zachariadis et al. (2009) and Wang et al. (2011).

However, 3L-CVRP just has been concerned in the late few years. Only a few relating research results can be searched. Bortfeldt (2012) introduces a hybrid algorithm including a tabu search algorithm for routing and a tree search algorithm for loading. Computational results for all publicly available test instances have been improved while the computational efforts are drastically reduced compared to other methods. Ruan et al. (2011) present a hybrid approach which combines Honey Bee Mating Optimization and six loading heuristic rules, one for vehicle routing and the others for three-dimensional loading, to solve the integrated problem. Martello et al. introduce a new least waste packing heuristic based on simple tabu search Gendreau et al. (2006), and Fuellerer et al. (2010) present ant colony optimization algorithm and fast packing heuristics. The works of Peng and Zhou (2011a, b) present two 3D loading algorithms, two initial solutions constructing algorithms, and the experimental results of 25 customers and 50 customers. Ning et al. (2009) introduce a new algorithm which divides the three-dimensional space into many small cuboids and uses the corresponding data structure to denote them. However, the algorithm depends on the segmentation of the initial three-dimensional space. In a word, the efficiency of the algorithms in existing results should be further improved, and the rationality of the models and algorithms still need to be further validated. Especially, the sizes of solved problems greatly limit the scopes of their practical applications. They are not appropriately used to solve vehicle routing problems in online supermarket, which are with large-scale loading items. Therefore, aiming at the delivery problems between supermarket's distribution center and the delivery stations, this paper studies the 3D loading constrained vehicle routing problem from the perspective of multistage optimization.

122.2 Problem Description

In a freight distribution center, ordered goods are packaged in several rectangular boxes, which must be firstly delivered to delivery stations. Each delivery station usually has a large number of packages (boxes) with various sizes. Here, we define 3L-CVRP in this paper as follows. It only has one depot and one type of vehicle. Let C = {1, 2, 3, 4, …, m} be the delivery vehicle set, V vehicle loading space, L the length of the space, W the width of the space, H the height of the space, S = {0, 1, …, n} be the set of station nodes, in which 0 represents the distribution center of online supermarket, $D = \{(i,j)|i,j \in V, i \neq j\}$ be the set of undirected edges (i, j) that connects all node pairs, m_i the number of goods in the delivery station i. Let v_{ik} be the space of package k in station i, l_{ik} its length, w_{ik} its width, and h_{ik} its height, $i = 1, 2, \ldots, n$, $k = 1, 2, \ldots, m_i$.

3L-CVRP problem must meet the following constraints.

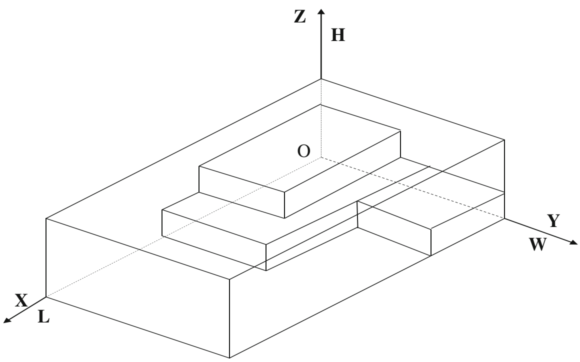
1. *Support constraint*. If a box could not be placed on the floor directly, it should be supported by other boxes with a certain percentage a.
2. *Last In First Out constraint*. When station i is served, all of its items must be unloaded through a sequence of straight movements parallel to the L-edge of the vehicle shown in Fig. 122.1.
3. *Volume constraint*. Each vehicle has a loading space constraint V.
4. *Station constraint*. Each delivery station can only be served once by a vehicle.
5. *Vehicle routing constraint*. Each route starts and ends at the depot, and the number of routes can not exceed the number of vehicles.

The objective is to minimize the total length of routes with the loading constraints.

122.3 A Solution Algorithm for 3L-CVRP

This paper will solve the problem by firstly designing heuristic-base loading algorithm and then arranging vehicle routing schemes.

Fig. 122.1 Residual loading capacity enumeration



122.3.1 Heuristic Rules for Loading

According to the actual situation of the packing problem, this paper designs the following heuristic rules to generate the packing schemes.

1. After loading, the number of feasible residual spaces is as few as possible.
2. Goods with larger volumes will firstly be loaded, and goods with similar sizes should be loaded together. For the goods delivered to the same station, they initially will be sorted in descending order by volume.
3. Load the goods to the boundary of the feasible space as near as possible, and make them be parallel to one of the surface. Other surfaces of goods can stick the surface of the vehicle, or to the face of other goods.

122.3.2 Residual Loading Capacity Enumeration

Residual loading capacity of a vehicle can be calculate by dividing it into several cube spaces (Baldacci et al. 2010), as shown in Fig. 122.1. Each cube space can be represented by the angle of the vertex coordinates A(x_1, y_1, z_1) and B(x_2, y_2, z_2). A is the nearest vertex of the feasible space away from the original coordinate 0(0, 0, 0), and B is the farthest vertex of the feasible space away from the original coordinate.

After the package G is placed in the feasible space M, we assume that G is placed in location (x_1, y_1, z_1) and location (a, b, c), then the residual loading capacity of M can be enumerated as following.

$$\begin{aligned}
&\mathrm{M1}: (x_1 + a,\ y_1, z_1) \text{ and } (x_2, y_2, c_2);\\
&\mathrm{M2}: (x_1, y_1 + b, z_1) \text{ and } (x_1 + a, y_2, z_1 + c);\\
&\mathrm{M3}: (x_1, y_1, z_1 + c) \text{ and } (x_1 + a, y_2, z_2).
\end{aligned}$$

Table 122.1 lists the corresponding conditions after M is updated by M1, M2 and M3.

When merging the feasible spaces, it is required to do the following judges. In the three-dimensional coordinates of the vehicle, let two feasible spaces be projected to surfaces X-O-Y, Y-O-Z, and X-O-Z. If two feasible spaces in which one side of the projection coincides and the two other surfaces of the projection have a coincided edge, then the two feasible spaces could be merged into one feasible space.

122.3.3 Three-Dimensional Loading Algorithm

According to heuristic rules for loading and residual loading capacity enumeration method, the following three-dimensional loading algorithm is designed.

Table 122.1 The residual loading capacity enumeration under different conditions

	$a = x_2 - x_1$	$b = y_2 - y_1$	$c = z_2 - z_1$
M1		√	√
M2	√		√
M3	√	√	
M1, M2			√
M1, M3		√	
M2, M3	√		
M1, M2, M3			
No space	√	√	√

Step 1: Get a list of the vehicle's spaces (denoted as List 1) and a list of alternate feasible spaces (denoted as List 2). According to the station, get the goods list (denoted as List 3) in which they are sorted in descending order by volume.
Step 2: If List 1 is empty, go to Step 6.
Step 3: Search List 1 to get minimum x_1, minimum y_1, and minimum z_1 as the next optimal space s.
Step 4: If List 3 is empty, go to Step 6.
Step 5: Search List 3, if the v_{ig}, l_{ig}, w_{ig}, h_{ig} of goods g meet the requirements of s, then load g in s, remove g from List 3, and update List 1, and go to Step 2. If all goods in List 3 do not meet the requirements of s, then add s to List 2, remove s from List 1, and go to Step 2.
Step 6: Add feasible spaces in List 2 to List 1, and let List 2 be empty. If List 3 is empty, then loading succeeds; if List 1 is empty and List 3 is not null, then loading fails.

122.3.4 Solution of Vehicle Routing Scheme

The steps of initial vehicle routing scheme generation are list as follows.

Step 1: Get the nearest distance $\mathrm{D}_{ik} = \min (\mathrm{D}_{ij})$ ($i = 1, \ldots\ldots, \mathrm{n}, j = 1, \ldots\ldots, \mathrm{n}$) between station i and other stations.
Step 2: Get a List 4 of stations which are sorted in descending order by D_{ik}.
Step 3: If List 4 is empty, then go to Step 9.
Step 4: Get first station p in List 4, generate a new distribution vehicle v, and then load goods of p in the vehicle v, and remove p from List 4.
Step 5: Find m delivery stations whose distance is the nearest away from p, sort them in ascending order, and get List 5.
Step 6: If List 5 is empty, then go to Step 3.
Step 7: If feasible spaces in v are not enough, move the first delivery station in List 5 to the first place in List 4, let List 5 be empty, and then go to Step 3.

Table 122.2 The numbers of items (boxes) in each delivery station

Box station	C_1	C_2	C_3	C_4	C_5	C_6	C_7	Total
S_1	16	19	12	13	14	19	14	107
S_2	14	10	10	13	10	12	17	86
S_3	10	18	16	20	12	16	13	105
……								
S_{20}	16	17	11	21	17	15	15	112

Table 122.3 Results of the experimental instance

Vehicle routing	Serviced delivery stations	Travel distance (km)	Total volume (m^3)
1	$S_3 \rightarrow S_7 \rightarrow S_{20} \rightarrow S_{16} \rightarrow S_{12}$	140	32.4825
2	$S_4 \rightarrow S_6 \rightarrow S_2 \rightarrow S_{19} \rightarrow S_{15}$	159	27.8511
3	$S_5 \rightarrow S_1 \rightarrow S_{18} \rightarrow S_{14} \rightarrow S_{10}$	133	31.7385
4	$S_8 \rightarrow S_{17} \rightarrow S_{13} \rightarrow S_{11} \rightarrow S_9$	150	25.8745

Step 8: Get the first station q from List 5, load goods of q in v. If goods of one station can not load in v, move q to the first place in List 4, remove q from List 5, and then go to Step 6.

Step 9: The initial solution is generated.

Due the vehicle routes are generated according to the nearest neighbor search, the combination of vehicle routes might not be optimal. Therefore, we have to adjust the routes to improve solution.

122.4 Computational Experiments

In order to verify the validity of the algorithm, we developed the algorithm in C# and run it on an Intel 2.1 GHz PC (Core 2 Duo E8500) with 4.0 GB RAM, running under Windows7. Then we construct the experimental instance by generating the parameters randomly. Three parameters for the vehicle's loading volume are $L = 5.5$, $W = 2.5$, and $H = 3$ m. There are 20 delivery stations, $\{S_1, S_2, \ldots, S_{20}\}$. For each station, the number of required items is randomly generated according to an uniform distribution between 80 and 120, and the distance between the stations is randomly generated according to an uniform distribution between 10 and 40 km. There are 7 kinds of packages, $\{C_1, C_2, \ldots, C_7\}$. So each item's volume is randomly generated among these 7 types. The numbers of items (boxes) in each delivery station are listed in Table 122.2. While generating the vehicle routing schemes, let $m = 6$. The calculation results are list in Table 122.3.

122.5 Conclusions

The capacitated vehicle routing problem in online supermarket distribution with three-dimensional loading constraints is a new and complex problem that combines the two classical problems of vehicle routing problem and pin packing problem, and the very large number of orders of online supermarket also makes the research more complicated.

Based on the heuristic knowledge, this paper combines three-dimensional loading with vehicle routing, effectively enhancing the algorithm optimization performance. It is efficient while being applied to the online supermarket logistics activities. It will enhance the optimization effect of the logistics process to some extent and thus decrease the delivery cost.

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Chapter 123
A TOPSIS Method Based on Triangle Fuzzy Number for Trust Evaluation in E-Commerce System

Dan Li

Abstract As a new technological environment and cooperation platform, e-commerce system provides the new opportunities for sharing and transferring information, knowledge and provides the new services for enterprises to participate in business interactions in the era of e-commerce. But there also exist kinds of risk in operation process. One kind of risk is lack of trust, and trust is the major barrier to the successful operation of e-commerce system. So it is necessary for enterprises to find out the influencing factors and the methods how to evaluate trust of e-commerce systems. It can help enterprises to enable better design and management of e-commerce system. Basing on TOPSIS and triangle fuzzy number, this research aims to propose an extended approach for assessing trust in e-commerce system. It is a multiple criteria evaluation problem under fuzzy environment. And then an example is given.

Keywords Trust evaluation · e-commerce system · TOPSIS · Linguistic variables · Triangular fuzzy number

123.1 Introduction

The notion of trust has been examined under various contexts such as bargaining, industrial buyer–seller relationship, cooperation relationship in alliances, economics and market research and even computer science (Marsh 1994; Peszynski and Thanasankit 2002).

With the continuous exploration and the support of emerging advanced information technologies, electronic commerce develops rapidly and causes a shift

D. Li (✉)
Business School, East China University of Political Science and Law, Shanghai, China
e-mail: huazhengld@126.com

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in business simulation is conducted. Electronic commerce, commonly known as e-commerce, refers to the transaction of products or services over the internet and other computer networks. The new technological environment and cooperation environment also provides the new opportunities for sharing and transferring information and knowledge, and provides the new services to participate in business interactions. However, there also exist different levels of risk in operation process. With the existence of risk comes the need for trust (Wojcik and Venter 2006). In the era of e-commerce, trust has been identified as a key for successful transaction and knowledge transferring. The lack of trust is cited as a major barrier to the successful operation of electronic commerce system. So it is necessary for enterprises to find out the influencing factors and the methods how to evaluate trust in order to improve the Capability of building trust of e-commerce system.

The evaluation problems are the process of finding the best candidate or making the best choice from all of the feasible alternatives. Trust evaluation in e-commerce system is a multiple criteria evaluation problem under fuzzy environment. It is suitable for organizations to adopt multiple criteria evaluation method to evaluate trust in e-commerce system.

Technique for order performance by similarity to ideal solution (TOPSIS) is one of the classical multiple criteria evaluation method. The concept of the method can be described that the best candidate should have the shortest distance from the positive ideal solution and the farthest from the negative ideal solution. The performance ratings and the weights of the criteria are given as crisp values (Chen 2000). This paper tries to propose an extended method basing on TOPSIS and triangle fuzzy number to evaluate trust of e-commerce system. The rating of each unit for participating in evaluation and the weight of each criterion are described by linguistic variables in triangular fuzzy numbers. Then, it is needed to calculate the distance between two triangular fuzzy numbers, and to determine the ranking order of all candidates according to the closeness coefficient. This paper aims to provide a method for deeply analyzing and measuring the capability of building trust in e-commerce system. The proposed method can also be applied to solve the problems such as project selection, partners' selection and other management decision problems.

123.2 The Proposed Method

For evaluating trust of e-commerce system, the extended method basing on TOPSIS and triangle fuzzy number in the fuzzy environment is proposed in this paper. It can solve the group decision-making or evaluation problem under fuzzy environment. In this paper, we assume that $A = \{A_1, A_2, \cdots, A_n\}$ is a set of all e-commerce systems participating in trust evaluation. And then form a committee of assessment experts. Assumed $R = \{R_1, R_2, \cdots, R_m\}$ is a set of given evaluation index, it includes policy orientation, credit of system, the quality of service, the quality of information, customer participation, customer satisfaction, the quality of

Table 123.1 Linguistic variables for the importance weight of each criterion and the ratings

Linguistic variables of weight	Linguistic variables of index	Corresponding triangle fuzzy numbers
Very low (VL)	Very bad (VB)	(0, 0, 0.1)
Low (L)	Bad (B)	(0, 0.1, 0.3)
Medium low (ML)	Worse than middling (WM)	(0.1, 0.3, 0.5)
Middling (M)	Middling (M)	(0.3, 0.5, 0.7)
Medium high (MH)	Better than middling (BM)	(0.5, 0.7, 0.9)
High (H)	Good (G)	(0.7, 0.9, 1.0)
Very high (VH)	Very good (VG)	(0.9, 1.0, 1.0)

system and so on (Xu and Liu 2007; Wang and Guo 2009; Wang 2009; Chen and Wei 2011). And then choose the appropriate linguistic variables for the importance weight of each criteria and the linguistic rating for all alternatives. The weight of criterion cannot completely certain, but it is clear that the importance weights of various criteria are considered as linguistic variables, it can be expressed as $\omega_i = [\alpha_i, \beta_i, \gamma_i]$, $0 \le \alpha_i \le \beta_i \le \gamma_i \le 1$. In Table 123.1 the linguistic variables can be expressed in triangular fuzzy numbers.

Assume that there are K persons in the evaluation group, the importance of the criteria and the rating of all alternatives can be calculated as:

$$\tilde{x}_{ji} = \frac{1}{K}\left[\tilde{x}_{ji}^{1}(+)\tilde{x}_{ji}^{2}(+)\cdots\tilde{x}_{ji}^{K}\right] \tag{123.1}$$

$$\tilde{\omega}_i = \frac{1}{K}\left[\tilde{\omega}_i^{1}(+)\tilde{\omega}_i^{2}(+)\cdots\tilde{\omega}_i^{K}\right] \tag{123.2}$$

$\tilde{x}_{ji}^K$ and $\tilde{\omega}_i^K$ are the rating and the importance weight of the Kth evaluator.

The algorithm of the multi-person multi-criteria evaluation with extended TOPSIS approach is given in the following (Chen 2000; Xiang 2011; Tang et al. 2008; Song and Wang 2010).

1. *Construct the fuzzy evaluation matrix in triangular fuzzy numbers*

$\tilde{x}_{ji} = \left(\rho_{ji}, \pi_{ji}, \sigma_{ji}\right)$ (i = 1,2,…,m) is the targeted value of criterion R_i for alternative $A_j(j = 1, 2, \cdots n)$ in triangular fuzzy numbers. Aggregate the weight of criteria to get the aggregated fuzzy weight ω_i of criterion R_i, and pool the evaluators' opinions to get the aggregated fuzzy rating of all alternatives according to the result of evaluating the criterion. The fuzzy multi-criteria evaluation problem which can be expressed in matrix format as

$$\tilde{F} = \begin{bmatrix} \tilde{x}_{11} & \tilde{x}_{12} & & \tilde{x}_{1m} \\ \tilde{x}_{21} & \tilde{x}_{22} & & \tilde{x}_{2m} \\ \cdots & \cdots & \cdots & \cdots \\ \tilde{x}_{n1} & \tilde{x}_{n2} & & \tilde{x}_{nm} \end{bmatrix} \tag{123.3}$$

$$\tilde{W} = [\tilde{\omega}_1, \tilde{\omega}_2, \ldots \tilde{\omega}_m] \tag{123.4}$$

2. *Construct the normalized fuzzy evaluation matrix*

It is necessary for using the linear scale transformation to transform the various criteria scales into a comparable scale without using the complicated normalization formula. Then the normalized fuzzy evaluation matrix denoted by $\bar{F}$ can be obtained. I_1 and I_2 represent the set of benefit criteria and cost criteria, respectively, that is

$$\bar{x}_{ji} = \left(\frac{\rho_{ji}}{\sigma_i^{\max}}, \frac{\pi_{ji}}{\sigma_i^{\max}}, \frac{\sigma_{ji}}{\sigma_i^{\max}}\right), i \in I_1 \tag{123.5}$$

$$\bar{x}_{ji} = \left(\frac{\rho_i^{\min}}{\sigma_{ji}}, \frac{\rho_i^{\min}}{\pi_{ji}}, \frac{\rho_i^{\min}}{\rho_{ji}}\right), i \in I_2 \tag{123.6}$$

$$\sigma_i^{\max} = \max_j\{\sigma_{ji}\}, \rho_i^{\min} = \min_j\{\rho_{ji}\} \tag{123.7}$$

The normalization method is to guarantee that the ranges of normalized triangular fuzzy numbers belong to [0, 1].

3. *Construct the weighted normalized fuzzy evaluation matrix*

Considering the different importance of each criterion, the weighted normalized fuzzy evaluation matrix can be constructed as

$$\begin{aligned} B = \omega \oplus \bar{F} &= \begin{bmatrix} \omega\tilde{x}_{11} & \omega\tilde{x}_{12} & & \omega\tilde{x}_{1m} \\ \omega\tilde{x}_{21} & \omega\tilde{x}_{22} & & \omega\tilde{x}_{2m} \\ \cdots & \cdots & \cdots & \cdots \\ \omega\tilde{x}_{n1} & \omega\tilde{x}_{n2} & & \omega\tilde{x}_{nm} \end{bmatrix} \\ &= \begin{bmatrix} y_{11} & y_{12} & & y_{1m} \\ y_{21} & y_{22} & & y_{2m} \\ \cdots & \cdots & \cdots & \cdots \\ y_{n1} & y_{n2} & & y_{nm} \end{bmatrix} \end{aligned} \tag{123.8}$$

$$y_{ji} = \omega_i \bar{x}_{ji} = \left(\delta_{ji}, \varepsilon_{ji}, \theta_{ji}\right)$$

4. *Determine the positive ideal alternative X^+ and the negative ideal alternative X^-*

$$y_j^- = \left(\min_{1 \le i \le m} \delta_{ji}, \min_{1 \le i \le m} \varepsilon_{ji}, \min_{1 \le i \le m} \theta_{ji}\right) = \left(\delta_i^-, \varepsilon_i^-, \theta_i^-\right)$$

$$y_j^+ = \left(\max_{1 \le i \le m} \delta_{ji}, \max_{1 \le i \le m} \varepsilon_{ji}, \max_{1 \le i \le m} \theta_{ji}\right) = \left(\delta_i^+, \varepsilon_i^+, \theta_i^+\right)$$

The positive ideal alternative is $X^+ = \left(y_1^+, y_2^+ \cdots y_n^+\right)$, the negative ideal alternative is $X^- = \left(y_1^-, y_2^- \cdots y_n^-\right)$.

5. *Calculate the distance of each alternative*

Now calculate the distance of each alternative from X_j and X^+, it can be described as

$$D_j^+ = D\left(X_j, X^+\right) = \sum_i^n \sqrt{\frac{\left[\left(\delta_{ji} - \delta_i^+\right)^2 + \left(\varepsilon_{ji} - \varepsilon_i^+\right)^2 + \left(\theta_{ji} - \theta_i^+\right)^2\right]}{3}} \quad (123.9)$$

Calculate the distance of each alternative from X_j and X^-, it can be described as

$$D_j^- = D\left(X_j, X^-\right) = \sum_i^n \sqrt{\frac{\left[\left(\delta_{ji} - \delta_i^-\right)^2 + \left(\varepsilon_{ji} - \varepsilon_i^-\right)^2 + \left(\theta_{ji} - \theta_i^-\right)^2\right]}{3}} \quad (123.10)$$

6. *Calculate the closeness coefficient of each alternative*

A closeness coefficient can determine the ranking order of all alternatives according to the $\mathrm{D_j^+}$ and $\mathrm{D_j^-}$ of each alternative. We can calculate the closeness coefficient of each alternative, it can be described as

$$C_j = \frac{D_j^-}{D_j^- + D_j^+} \quad (123.11)$$

According to the closeness coefficient, the ranking order of all alternatives can be determined.

123.3 Illustrative Example

The example is given for explaining the process and method that how to measure the degree of trust in e-commerce system and the evaluation method is described.

Suppose there are three e-commerce systems A_1, A_2 and A_3 need to be evaluated the capability of building trust. A committee of three evaluators, M_1, M_2 and M_3 has been formed to conduct the interview. During the process of trust evaluation, five benefit criteria are chosen as evaluation criteria: credit of system (R_1), the quality of service (R_2), the quality of information and knowledge (R_3), customer satisfaction (R_4) and the quality of system (R_5).

The linguistic weighting variables (shown in Table 123.1) are used by evaluators to assess the importance of the criteria following as Table 123.2.

Table 123.2 The importance weight of the criteria

	M_1	M_2	M_3
R_1	MH	H	VH
R_2	H	VH	H
R_3	MH	MH	VH
R_4	VH	H	M
R_5	M	H	VH

Table 123.3 The ratings of three e-commerce systems by evaluators under all criteria

Criteria	Candidates	Evaluators		
		M_1	M_2	M_3
R_1	A_1	G	VG	G
	A_2	BM	G	M
	A_3	BM	VG	VG
R_2	A_1	G	M	BM
	A_2	M	BM	G
	A_3	G	VG	BM
R_3	A_1	M	WM	G
	A_2	BM	VG	G
	A_3	G	M	BM
R_4	A_1	WM	BM	G
	A_2	M	G	VG
	A_3	BM	G	M
R_5	A_1	G	VG	WM
	A_2	VG	M	BM
	A_3	WM	VG	G

The linguistic rating variables can be used by evaluators to evaluate the rating of alternatives with respect to each criterion. It can be described in Table 123.3.

The linguistic evaluation can be described by triangular fuzzy numbers to construct the fuzzy evaluation matrix. The fuzzy weight of each criterion can be determined as Table 123.4.

Then the weighted normalized fuzzy evaluation matrix can be constructed as Table 123.5.

The positive ideal alternative can be determined as

Table 123.4 The fuzzy evaluation matrix and fuzzy weights of three e-commerce systems

	Weight	A_1	A_2	A_3
R_1	(0.7, 0.87, 0.97)	(0.77, 0.93, 1)	(0.5, 0.7, 0.87)	(0.77, 0.9, 1)
R_2	(0.54, 0.93, 1)	(0.5, 0.7, 0.87)	(0.5, 0.7, 0.87)	(0.7, 0.87, 0.97)
R_3	(0.34, 0.8, 0.93)	(0.37, 0.57, 0.73)	(0.7, 0.87, 0.97)	(0.5, 0.7, 0.87)
R_4	(0.63, 0.8, 0.9)	(0.43, 0.63, 0.8)	(0.63, 0.8, 0.9)	(0.5, 0.7, 0.87)
R_5	(0.63, 0.8, 0.9)	(0.57, 0.73, 0.83)	(0.57, 0.73, 0.87)	(0.57, 0.73, 0.83)

Table 123.5 The fuzzy weighted normalized evaluation matrix

	A_1	A_2	A_3
R_1	(0.54,0.81,0.97)	(0.35,0.61,0.84)	(0.54,0.78,0.97)
R_2	(0.28, 0.67, 0.9)	(0.28, 0.67, 0.9)	(0.39, 0.84, 1)
R_3	(0.13, 0.47, 0.7)	(0.24, 0.72, 0.93)	(0.18, 0.58, 0.84)
R_4	(0.3, 0.56, 0.8)	(0.44, 0.71, 0.9)	(0.35, 0.62, 0.87)
R_5	(0.42, 0.67, 0.86)	(0.42, 0.67, 0.9)	(0.42, 0.67, 0.86)

$$\begin{aligned} X^+ =&\{(0.54, 0.81, 0.97)(0.39, 0.84, 1)(0.24, 0.72, 0.93)\\ &(0.44, 0.71, 0.9)(0.42, 0.67, 0.9)\} \end{aligned}$$

The negative ideal alternative can be determined as

$$\begin{aligned} X^- = &\{(0.35, 0.61, 0.84)(0.28, 0.67, 0.9)(0.13, 0.47, 0.7)\\ &(0.3, 0.56, 0.8)(0.42, 0.67, 0.86)\} \end{aligned}$$

The distance of each e-commerce systems from the positive ideal alternative and the negative ideal alternative can be calculated, respectively, as

$$\begin{aligned} D_1^+ =&D(A_1, X^+) = 0.4914\\ D_1^- =&D(A_1, X^-) = 0.1761\\ D_2^+ =&D(A_2, X^+) = 0.3065\\ D_2^- =&D(A_2, X^-) = 0.3513\\ D_3^+ =&D(A_3, X^+) = 0.2180\\ D_3^- =&D(A_3, X^-) = 0.4629 \end{aligned}$$

The closeness coefficient of each e-commerce systems can be calculated as

$$\mathrm{C1} = 0.2638,\ \mathrm{C2} = 0.5341,\ \mathrm{C3} = 0.6798$$

According to the closeness coefficient, the ranking order of the e-commerce systems is A_3, A_2 and A_1. Obviously, A_3 has the strongest capability of building trust.

123.4 Conclusions

The study is mainly focused on the trust evaluation of e-commerce system. Trust evaluation in e-commerce system is a multiple criteria evaluation problem under fuzzy environment. In this paper, an extended TOPSIS evaluation method is used for trust evaluation in e-commerce system. An illustrative example is provided to demonstrate and explain how it operates. Results of this study can help enterprises to evaluate trust of e-commerce system and improve the rate of successful transaction and the system service performance.

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Chapter 124
Cold-Start Collaborative Filtering Based on User Registration Process

Peng-yu Zhu and Zhong Yao

Abstract A key challenge in recommender system research is how to make recommendations to new users. Recently the idea of solving the problem within the context of learning user and item profiles has been proposed. Those methods constructed a decision tree for the initial interview, enabling the recommender to query a user adaptively according to her prior responses. However, those methods have overlooked the new users' personal attributes. In this paper, we present the method CCFBURP, which constructs an algorithm with two steps, in the first of which we screen neighbors of the target user, using its personal attributes, while in the second of which we train the interview model on the dataset constituted of the neighbors and alternative projects. Then the recommender system forecasts goal of optional project ratings of the target user. Experimental results on the MovieLens dataset demonstrate that the proposed CCFBURP algorithm significantly outperforms existing methods for cold-start recommendation.

Keywords Collaborative filtering · Recommender systems · Cold-start problem · User registration process

124.1 Introduction

Increasing people have declined to purchase interesting items from Internet, yet the boom of information relevant to customers, products and transactions has lead to information overload problem in E-Commerce (Huang et al. 2004). Meanwhile, in order to supply customers with various personal services, personalized recommender systems with recommendation techniques have been widely applied,

P. Zhu (✉) · Z. Yao
School of Economics and Management, Beihang University, Beijing, China
e-mail: zhupengyu@sem.buaa.edu.cn

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which have already been considered one of the most important methods of personal service in websites (Wei et al. 2007). The developers of *Tapestry* (one of the first recommender systems) coined the phrase "collaborative filtering (CF)," which has been widely adopted in practice (Goldberg et al. 1992).

A key challenge for building an effective CF recommender system is the well-known cold-start problem—*How to provide recommendations to new users*? New users are unlikely to be given good recommendations for the lack of their rating or purchase history (Adomavicius and Tuzhilin 2005). Pure collaborative filtering methods base their recommendations on community preferences (e.g., user ratings and purchase histories), which would ignore user and item attributes (e.g., demographics and product descriptions) (Breese et al. 1998; Hill et al. 1995; Konstan et al. 1997; Resnick and Varian 1997; Shardanand and Maes 1995).

A vast amount of methods have been introduced to solve the cold-start problem. Schein et al. (2002) proposed the aspect model latent variable method for cold-start recommendation, which combines both collaborative and content information in model fitting. Kim and Li (2004) proposed a probabilistic model to address the cold-start problem, in which items are classified into groups, and predictions are made for users considering the Gaussian distribution of user ratings. On the other hand, much of the collaborative filtering literature have focused on factor models recently, for instance, variants of the singular value decomposition (SVD) (Paterek 2007). However, in code recommender systems, the available data consists of calls to methods in contexts. This data seems to be binary: given a context- method pair, it predicts whether or not the method is called within this context (Weimer et al. 2009).

A natural approach to solving the cold-start problem is to elicit new user preferences by querying users' responses progressively through an initial interview process (Golbandi et al. 2010). Specifically, at the visit of a new user, the recommender provides a seed item as a question and asks the user for her opinion; based on which the recommender gradually refines the user's characterization that can provide more satisfactory recommendations to the user in the future. Zhou et al. (2011) proposed the *Functional Matrix Factorizations* (FMF) method based on the thought of query responses and functional matrix factorizations. Their method has been demonstrated to be effective in cold-start recommendation problems by experimental results.

The shortage of FMF is that it has overlooked the users' personal attributes, for instance, their age, sex, vocation, location. In this paper, we present a method *Cold-start Collaborative Filtering Based on User Registration Process* (CCF-BURP), i.e. a novel cold-start recommendation method that estimates users' preferences through collecting information in their registration process. Our proposed method tends to explore the correlation between users more effectively. In CCFBURP, we construct a two-step algorithm, in the first of which we screen neighbors of the target user using its personal attributes, and in the second we train the interview model on the dataset constituted of the neighbors and alternative projects. Then the recommender system forecasts goal of optional project ratings of the target user. Experimental results on the MovieLens dataset demonstrate that the proposed CCFBURP algorithm significantly outperforms existing methods for cold-start recommendation.

The remainder of this paper is organized as follows: In Sect. 124.2, matrix factorization for collaborative filtering are introduced in the first place, followed by the presentation of functional matrix factorization for constructing the interview process of cold-start collaborative filtering by restricting the user profiles to be a function in the form of a decision tree. In Sect. 124.3, FMF is optimized with adopting users' personal attributes, and then the progress of CCFBURP is constructed. Then, the evaluation of the proposed method on the MovieLens dataset is carried on and the results in Sect. 124.4 is analyzed. Finally in Sect. 124.5, the conclusion is drawn along with presenting several future directions.

124.2 Functional Matrix Factorization Decision Tree

In this section, we describe the functional matrix factorization (FMF) method for cold-start collaborative filtering which explores the well-known matrix factorization methods for constructing the interview process. The key innovation is that we parameterize user profiles to be a function of the responses to the possible questions of the interview process and use matrix factorization to compute the profiles.

124.2.1 Low Rank Approximation of the Rating Matrix

Consider tabulated data, organized in the observed matrix $R \in R^{n \times m}$, which we seek to approximate by a product of two matrices $R = U'V$. So we got

$$r_{ij} = \sum_k u_{ki} v_{kj} = u_i^T v_j, \quad i \in [1, n], \quad j \in [1, m]$$

where r_{ij} corresponds to the rating of item j by user i.

Given the set of known ratings, the parameters u_i and v_j can be estimated through fitting the training data by solving the following optimization problem:

$$\min_{u_i v_j} \sum_{\{(i,j)\} \in O} \left(r_{ij} - u_i^T v_j \right)^2$$

The problem can be solved by existing numerical optimization methods. In our implementation, we use the alternating optimization for its amenability for the cold-start settings. Specifically, the optimization process performs the following two updates alternatively.

First, for $i = 1, 2, \ldots, n$, minimizing with respect to u_i with all $u_i, j \neq i$ and all v_j fixed:

$$u_i = \arg\min_{u_i} \sum_{(i,j)\in O} \left(r_{ij} - u_i^T v_j\right)^2$$

it is a linear regression problem with squared loss. The closed form solution can be expressed as

$$u_i = \left(\sum_{(i,j)\in O} v_j v_j^T\right)^{-1} \left(\sum_{(i,j)\in O} r_{ij} v_j\right)$$

Similarly, for $j = 1, 2, \ldots, m$, we can approximate v_j with the closed form solution which can be expressed as

$$v_j = \left(\sum_{(i,j)\in O} u_i u_i^T\right)^{-1} \left(\sum_{(i,j)\in O} r_{ij} u_i\right)$$

124.2.2 Functional Matrix Factorization

Now we consider constructing the interview process for cold-start collaborative filtering. Assume that a new user registers at the recommendation system and nothing is known about her. To capture the preferences of the user, the system initiates several interview questions to query the responses from the user. Based on the responses, the system constructs a profile for the user and provides recommendations accordingly. We propose to parameterize the user profile u_i in such a way that the profile u_i is tied to user i's responses in the form of a function.

Assume there are P *possible interview questions*, and an answer to a question takes value in the finite set $\{-1, 1, 0\}$, representing "Dislike", "Like" and "Unknown", respectively. Then, we introduce a P-dimensional vector a_i, which denotes the representing the answers of user i to the P questions. And we tie the profile to the answers by assuming $u_i = T(a_i)$, where T is a function that maps the responses a_i to the user profile $u_i \in R^K$. So we get $r_{ij} = v_j^T T(a_i)$.

Our goal is to learn both T and v_j from the observed ratings. To this end, substituting $u_i = T(a_i)$ into the low rank matrix factorization model, we have the following optimization problem:

$$T, V = \arg\min_{T\in \mathrm{H}, V} \sum_{(i,j)\in O} \left(r_{ij} - v_j^T T(a_i)\right)^2 + \lambda \|V\|^2 \qquad (124.1)$$

This objective function can be optimized through an alternating minimization process.

1. Given $T(a)$, we can compute v_j by regularized least square regression.

$$v_j = \arg\min_{v_j} \sum_{(i,j)\in O} \left(r_{ij} - v_j^T T(a_i)\right)^2 + \lambda \left\| v_j \right\|^2$$

This problem has a closed-form solution given by

$$v_j = \left(\sum_{(i,j)\in O} T(a_i)T(a_i)^T + \lambda I \right)^{-1} \left(\sum_{(i,j)\in O} r_{ij} T(a_i) \right) \tag{124.2}$$

where I is the identity matrix of appropriate size.

2. Given v_j, we try to fit a decision tree $T(a)$ such that

$$T = \arg\min_{T\in \mathrm{H}} \sum_{(i,j)\in O} \left(r_{ij} - T(a_i)^T v_j\right)^2 \tag{124.3}$$

To reduce the implementation and computational complexity, we address this problem by proposing an efficient greedy algorithm for finding an approximate solution.

124.2.3 Decision Tree Construction

Starting from the root node, the set of users at current node are partitioned into three disjoint subsets $R_L(p)$, $R_D(p)$ and $R_U(p)$ corresponding to "Like", "Dislike" and "Unknown" of their responses to the interview question p:

$$\begin{aligned} R_L(p) &= \{ i | a_{ip} = \text{``}Like\text{''} \} \\ R_D(p) &= \{ i | a_{ip} = \text{``}Dislike\text{''} \} \\ R_U(p) &= \{ i | a_{ip} = \text{``}Unknown\text{''} \} \end{aligned}$$

To find the optimal question p that leads to the best split, we minimize the following objective:

$$\begin{aligned} \min_p \sum_{i\in R_L(p)} \sum_{(i,j)\in O} \left(r_{ij} - u_i^T v_j\right)^2 + \sum_{i\in R_D(p)} \sum_{(i,j)\in O} \left(r_{ij} - u_D^T v_j\right)^2 \\ + \sum_{i\in R_U(p)} \sum_{(i,j)\in O} \left(r_{ij} - u_U^T v_j\right)^2 \end{aligned} \tag{124.4}$$

where u_L, u_D and u_U are the optimal profiles for users in the child nodes corresponds to the answers of "Like", "Dislike" and "Unknown", respectively:

$$u_L = \arg\min_u \sum_{i \in R_L(p)} \sum_{(i,j) \in O} \left(r_{ij} - u^T v_j\right)^2$$
$$u_D = \arg\min_u \sum_{i \in R_D(p)} \sum_{(i,j) \in O} \left(r_{ij} - u^T v_j\right)^2$$
$$u_U = \arg\min_u \sum_{i \in R_U(p)} \sum_{(i,j) \in O} \left(r_{ij} - u^T v_j\right)^2$$

After the root node is constructed, its child nodes can be constructed in a similar way, recursively. Finally, we can get the users' profiles when he arrived in a leaf node of the decision tree. Then, the estimated rating of user i to item j can be expressed as $\hat{r}_{ij} = v_j^T u_i$.

124.3 Cold-Start Collaborative Filtering Based on User Registration Process

124.3.1 User Dissimilarity Matrix

FMF assumed that a new user who registered at the recommendation system was a black stranger before she answered the interview questions. However, thanks to her registration process, we do know something about her personal attributes, such as age, sex, vocation, location, etc. Generally, people with similar attributes are likely to share their interests in similar things. For example, most boys at the age of 15–20 likes *The Pirates of the Caribbean* and *Harry Potter*, while the men of 55–60 ages prefer *Casablanca*. Therefore, it will be more accurately for new users to recommend the resources which are enjoyed by the similar users, who have similar personal attributes with the new ones.

We introduced *User Dissimilarity Matrix* to measure the dissimilarity between two users. Assume there are p kinds of personal attributes in the *user dataset*, dissimilarity between u_i and u_j can be expressed as:

$$d(i,j) = \frac{\sum_{f=1}^{p} \delta_{ij}^{(f)} d_{ij}^{(f)}}{\sum_{f=1}^{p} \delta_{ij}^{(f)}} \tag{124.5}$$

x_{if} and x_{jf} corresponds to attribute f of u_i and u_j. If x_{if} or x_{jf} is null value, or $x_{if} = x_{jf} = 0$, $\delta_{ij}^{(f)} = 0$. In other cases, $\delta_{ij}^{(f)} = 1$.

1. When attribute f is a dyadic scalar or a nominal variable.

   If $x_{if} = x_{jf}$, $d_{ij}^{(f)} = 0$, or $d_{ij}^{(f)} = 1$.

   For dyadic scalars, the dissimilarity could be calculated through the simple matching method.

$$d(i,j) = \frac{p-m}{p}$$

where p corresponds to the number of all variables, and m corresponds to the number of variables that user i and j matched.

2. When attribute f is an interval variable.

$$d_{ij}^{(f)} = \frac{|x_{if} - x_{jf}|}{\max_h x_{hf} - \min_h x_{hf}}$$

where h includes all non-null objects of attribute f.

For interval variables, the dissimilarity is usually calculated by distance between users. Euclidean distance has been most widely used:

$$d(i,j) = \sqrt{|x_{i1} - x_{j1}|^2 + |x_{i2} - x_{j2}|^2 + \cdots + |x_{ip} - x_{jp}|^2}$$

In the user dissimilarity matrix, $d(i,j)$ corresponds to the dissimilarity between user i and user j. Given a threshold α, if $d(i,j) \leq \alpha$ user i and j could be a neighbor to each other.

124.3.2 Cold-Start Collaborative Filtering Based on User Registration Process

To construct the *Cold-start Collaborative Filtering Based on User Registration Process*, the user dissimilarity matrix must be structured as a necessary preparation. And we should choose the appropriate measures of users' attributes.

In the MovieLens dataset, users' attributes were stored in table u.user, which had a tab separated list of user id, age, gender, occupation and zip code. We defined the variables in Eq. (124.5) as follows:

1. All $\delta_{ij}^{(f)} = 1$, $f \in [1,4]$, for all users' attributes are not null value.
2. If the age difference between the two users is no more than 5, $d_{ij}^{(1)} = 0$. If the difference is more than 5, $d_{ij}^{(1)} = 1$.
3. If the two users' genders are the same, $d_{ij}^{(1)} = 0$, or $d_{ij}^{(1)} = 1$.
4. If the two users' occupations are the same, $d_{ij}^{(1)} = 0$, or $d_{ij}^{(1)} = 1$.

5. As we know, the first number of zip code in USA corresponds to several neighboring states, and we supposed that people who live in neighboring states have some kind of similarity. So we can present that if the two users' zip codes start with a same number, $d_{ij}^{(1)} = 0$. If not, $d_{ij}^{(1)} = 1$.

We suggested a registration progress for new users, which consists of two parts. First, the new users registered an account and provided her personal information. Then we computed the dissimilarities between the new user and old ones. After that, we could find her neighbors from the existing users whose dissimilarities with her were less than or equal to the given α. These neighbors' rating to all items constituted her modelling data set, witch was denoted as R^*. Afterwards the n items that had got the most ratings in R^* were selected to be *possible interview questions*. Second, we trained the decision tree $T(a)$ and v_j through the progress mentioned in Sect. 124.3.

124.3.3 Computational Complexity

The computation complexity for constructing the decision tree of FMF in Sect. 124.2 is

$$O\left(D\sum_i N_i^2 + LMK^3 + LM^2K^2\right) \tag{124.6}$$

where D is the depth of the tree, N_i is the number of ratings by the user i. L represents the number of nodes in the tree, M is the number of *possible interview questions*, K is the dimension of the latent space. In all of these variables, D, N_i, L *and* K can be assigned by administrator. M is the amount of all the items without further restrictions, which could be a really huge number.

In Sect. 124.3, we chose the top-N items as *possible interview questions*, which had got the most ratings from the neighbors of the new user. The computation complexity turned into

$$O\left(D\sum_i N_i^2 + LNK^3 + LN^2K^2\right) \tag{124.7}$$

N is far less than M under ordinary circumstances. For instance, M is 1,682 in our MovieLens dataset. If we set N to be 150, the second part of the computation complexity reduced to less than 10 %, as well as the third part to l see than 1 %. As the user number increased, the effect became more apparent.

124.4 Experiments

124.4.1 Data Set

The MovieLens data set has been widely used in the field of CF. It contains 3,900 movies, 6,040 users and around 1 million ratings, the ratings are integers ranging from 1 (bad) to 5 (good). In our experiments, we choose the reduced data, which contains 1,682 movies, 943 users, 100,000 ratings, and each user in the reduced data has rated at least 20 movies.

We split the users into two disjoint subsets, the training set and the test set, containing 80 and 20 % users. Then we split the items in the test set into two disjoint subsets, the answer set containing 80 % items, which is used to generate the user responses in the interview process, while the evaluation set containing the rest 20 % items, which is used to evaluate the performance after the interview process. The data set is divided as in Fig. 124.1, where A represents the training set, B is the answer set, and C is the evaluation set.

124.4.2 Performance Evaluation

The performance of a collaborative filtering algorithm will be evaluated in terms of the widely used root mean square error (RMSE) measure, which is defined as follows

$$RMSE = \sqrt{\frac{\sum_{i=1}^{n} \left(r_{ij} - \hat{r}_{ij}\right)^2}{N}}$$

where N represents the amount of test ratings, r_{ij} is the ground truth values for movie j by user i and $\hat{r}_{ij}$ is the predicted value by our algorithm.

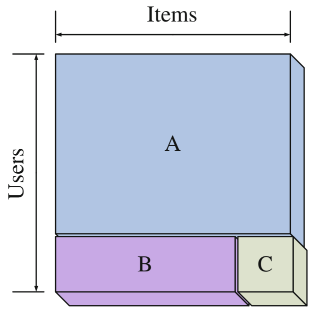

Fig. 124.1 Division of the data set

124.4.3 Results and Analysis

We compare the performance with four baseline methods described as follows:

Mode Method (*MM*): In the whole training set, find the mode of ratings for movies by all users, and predict the ratings in the test set as the mode value.

Mean Value Method (*MVM*): In the whole training set, compute the mean value of ratings for movies by all users, and predict the ratings in the test set as the mean value.

Neighbor Mode Method (*NMM*): In the optimized training set which is composed of the N neighbors of the new user, find the mode of ratings for movies by all users, and predict the ratings in the test set as the mode value.

Neighbor Mean Value Method (*NMVM*): In the optimized training set which is composed of the N neighbors of the new user, compute the mean value of ratings for movies by all users, and predict the ratings in the test set as the mean value.

We set $D = 5$ *and* $K = 20$ in Eqs. (124.6) and (124.7), and we provide $\alpha = 0.5$. Then we consider different $N = 10, 50, 100, 150, 300$ in Eq. (124.7), same as N in *NVM* and *NMVM* respectively. The RMSE results are is reported in Table 124.1, and depicted in Fig. 124.2.

Table 124.1 RMSE on MovieLens data set for cold-start users with respect to the number of neighbors

	$N = 10$	$N = 50$	$N = 100$	$N = 150$	$N = 300$
MM	1.0451				
MVM	1.1548				
NMM	1.2547	1.0836	1.0147	0.9875	1.0348
NMVM	1.3120	1.2055	1.1348	1.0895	1.1446
FMF	0.9536				
CCFBURP	1.2664	0.9825	0.9457	0.9327	0.9396

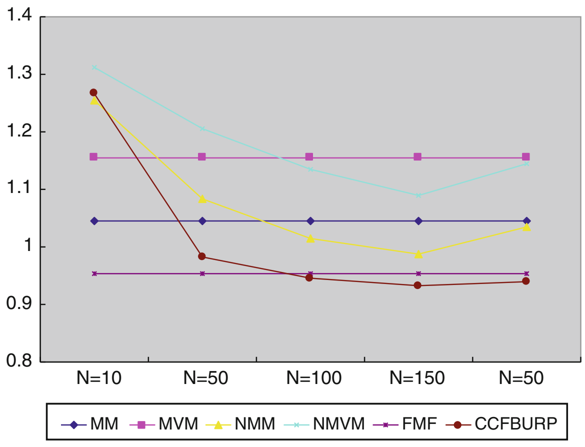

Fig. 124.2 RMSE of MM, MVM, NMM, NMVM, FMF and CCFBURP for cold-start users on MovieLens data set

Comparing the performance of MM, MVM and FMF, we can see that FMF is superior to the others, as same as CCFBURP to NMM and NMVM. This observation illustrate that the interview processes in FMF and CCFBURP are beneficial to improve the algorithm accuracy. Then we compare MM with NMM, MVM with NMVM and FMF with CCFBURP in pairs. We can see that the formers are static while the latter ones are dynamic respond to the changes of N, the RMSE first decreases, and reaches the optima around $N = 150$, thereafter, the RMSE increases and tends to the results of the formers. We attribute this to the fact that when N is too small, the predicted ratings are influenced much by preconception of the selected users. As N increasing, the influence of preconception decreases, and RMSE decreases. However, as N continues increasing, it is getting closer and closer to the number of all items, which is why the RMSE tends to the results of the static algorithms.

124.5 Conclusion

The main focus of this paper is on the cold-start problem in recommender systems. We have presented the *Cold-start Collaborative Filtering Based on User Registration Process*, a framework for learning latent factors for user/item profiling. The proposed CCFBURP algorithm has considered the whole registration process of new users, and used the information issued from the process to predict the users' performance. Experimental results on the MovieLens dataset demonstrate that the proposed CCFBURP algorithm significantly outperforms existing methods for cold-start recommendation. For future work, we plan to investigate the influence of parameter variation. Moreover, we also plan to explore the rules of calculating the dissimilarity, which plays an important role in the first step of CCFBURP.

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Chapter 125
Design and Implementation of Distribution Management System Based on the Ceramics E-Business Platform

Fu-bao He, Yi-lai Zhang and Hua Huang

Abstract This paper illustrates design ideas, functions design and implementation of the distribution management system based on the ceramics e-business platform. The system can open up and broaden the network distribution channel for the ceramics manufacturing enterprises, realize management to the network distributors through controlling price and authorizing products classification and other methods, and realize the integration of the traditional and network distribution channel. Meanwhile, the system can provide zero inventory network distribution for the ceramics marketing enterprises or individuals (distributors) under supervision and management of the ceramics manufacturing enterprises, which can avoid the overstocking problem and the trouble of the heavy investment in the traditional distribution channel. Finally, this paper gives an application case of the system.

Keywords E-business · Distribution management system · Ceramics manufacturing enterprises · Network distribution channel

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F. He (✉) · Y. Zhang · H. Huang
School of Information and Engineering, Jingdezhen Ceramic Institute,
Jingdezhen, People's Republic of China
e-mail: 26172324@qq.com

Y. Zhang
e-mail: jdzzyl@163.com

H. Huang
e-mail: jdz_hh@qq.com

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125.1 Introduction

With the rapid development of the Internet and the application of the network technology, e-business has developed rapidly worldwide. With the globalization, low cost, high efficiency and interactivity, e-business makes changes not only to the enterprises' production and operation activities, but also to impact on the distribution channel. The competition among enterprises gradually transformed into the competition of distribution channel, those who mastered the efficient distribution channel will be able to get an unassailable position in the modern competitive society (Zhang and Li 2010). The distribution channel is a bridge connecting enterprises, market, products and customers (Long 2010). The products manufactured by the enterprises can flow into the market to meet with the customers and flow into the field of consumption through the bridge. There will be no sales without the bridge (Liu 2006). The excellent enterprises regard the establishment of distribution channel as the key to expand and dominate the market (Xi et al. 2010). To the traditional enterprises of ceramic industry, they must carry out innovation of distribution channel and changing in supervision and management of the distribution channel to adapt to the changing of market environment. This paper researches the distribution management system based on the ceramics e-business platform and tries to: open up and broaden network distribution channel for the ceramics manufacturing enterprises; realize supervision and management of network and traditional distributors through controlling price and authorizing products classification and other methods; realize integration of traditional and network distribution channel; provide a new zero inventory network distribution pattern for the distributors under the ceramics manufacturing enterprise's management and supervision.

125.2 Design Ideas of the System

With the economic globalization, continuous progress of science and technology, the rapid development of productivity, the emergence and development of e-business, the issue of network distribution channel has never been attached importance to by the enterprises like today (Zhao 2008). At present, the ceramics manufacturing enterprises are promoting sales through the traditional distribution channel, the architectural ceramics enterprises mainly sells through the traditional distribution channel of franchised dealer and monopolization, and the domestic ceramics enterprises mainly uses the way of wholesale and retail to sell. However, with the enlargement of enterprises in scale and the diversification of business activities, the supervision and management of distribution channel have become more complex. With the great changes in network economy and market environment, the traditional ceramics manufacturing enterprises must carry out innovation of distribution channel and changing in supervision and management of the distribution channel to adapt to the changes. In the era of rapid development of e-business, establishing the distribution management system to cover the entire distribution channel, share information, support analysis and decision, and make marketing keep pace with the market, which has become a problem need to solve to the ceramics manufacturing enterprises.

In order to supervise and manage the distribution channel for the ceramics manufacturing enterprises better, open up and broaden the network distribution channel for the ceramics manufacturing enterprises, this paper tries to develop the distribution management system based on the ceramics e-business platform. After associating distributors with the ceramics manufacturing enterprise, changing them into the system's suppliers and distributors, providing the needed functions for them, the ceramics manufacturing enterprises can realize network management of distributors in the traditional distribution channel, open up and broaden network distribution channel, and realize integration of the traditional and network distribution channel; the distributors can get zero inventory network distribution pattern under management and supervision of the ceramics manufacturing enterprises.

125.3 Establishment of the Network Distribution Channel

With the appearance and development of e-business, it is leading a new distribution pattern with its fast, efficient and low cost advantages, which bring enterprises opportunities and impact on the traditional distribution channel (Wang 2004). Distribution channel is a transferring route of products from the manufacturers to consumers (Deng 2007). And traditional distribution channel is the distribution system with independent traditional distributors based on "big distribution, big production", which can finish the transfer of capital flow, logistics, and information flow in the products' transferring from the manufacturers to the consumers (Yang 2004). More and more ceramics manufacturing enterprises are opening up and broadening network distribution channel quickly. The establishment of the network distribution channel should have the right transfer functions of capital flow, logistics, and information flow like in the traditional distribution channel (Wu 2011). The establishment of the network distribution channel is an important part of the distribution management system based on the ceramics e-business platform, which associate distributors with the ceramics manufacturing enterprises (suppliers), change them into the system's suppliers and distributors and provide the needed functions for them. The Network distribution channel's establishment is shown in Fig. 125.1.

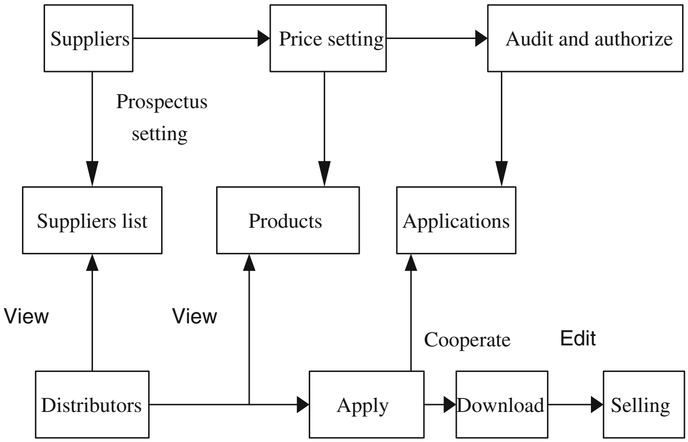

Fig. 125.1 The network distribution channel's establishment

125.4 Functions Design of the System

The system this paper illustrated is based on the existing ceramics e-business platform's necessary functions which mainly include: products display, products searching, payment, products and orders management in the background of the cyber shop. So, the functions design of the distribution management system based on the ceramics e-business platform focus on design of new functions only. According to the design ideas, the functions of the system can be divided into the supplier module and the distributor module. The supplier's functions includes: products management, distributors' management, setting prospectus and supply–distribution orders; the distributor's function includes: suppliers' management, Distribution products management and orders of distribution.

125.4.1 Functions Explainment of the Supplier Module

1. *Products management*: Setting the products can be distributed or not; editing the distribution price, the suggestion sale price, the lowest and highest sale price of the product; and modifying the distribution product's description.
2. *Distributors's management*: Refuse or agree the application of one distributor; after cooperation, reduce, add or view the authorized products classification to the distributor in cooperation; see the information of the distributors in cooperation; apply to stop cooperation with one distributor.
3. *Prospectus setting*: Begin or stop the prospectus; setting the conditions of cooperation

4. *Supply–distribution orders*: View the order is paid or not from the right distributor; stop the order; deliver the products according the order; view the statistics of the orders.

125.4.2 The Functions Explainment of the Distributor Module

1. *Suppliers management*: View the products information of one supplier in the suppliers list; view the suppliers can join; choose one supplier and apply to begin cooperation; view state of the applications; after cooperation, see the information of the products classification authorized by the right supplier in cooperation; view the supplier's information in cooperation; apply to stop cooperation with one supplier.
2. *Distribution products management*: Download the distribution products of one supplier according to the authorized products classification; editing the sale price between the lowest and highest sale price of the right product; delete the distribution products; up selling or not.
3. *Orders of distribution*: View the order is paid or not from the right buyer; stop the order; pay money to the right supplier; inform the supplier to deliver the right products; view the statistics of the orders.

125.5 Implementation of the System

This paper completes research and development of the distribution management system based on the ceramics e-business platform, according to the functions design of the distribution management system, inserting necessary columns based on the existing cyber shop and products table, and adding the authorized products classification table and supply–distribution association tables etc., with SQL Server 2000 and Microsoft Visual Studio 2008 (He et al. 2011).

125.5.1 Implementation of the Supplier Module

The supplier's functions includes: products management, distributors management, setting prospectus and supply–distribution orders. The sketch menu of supplier is shown in Fig. 125.2a.

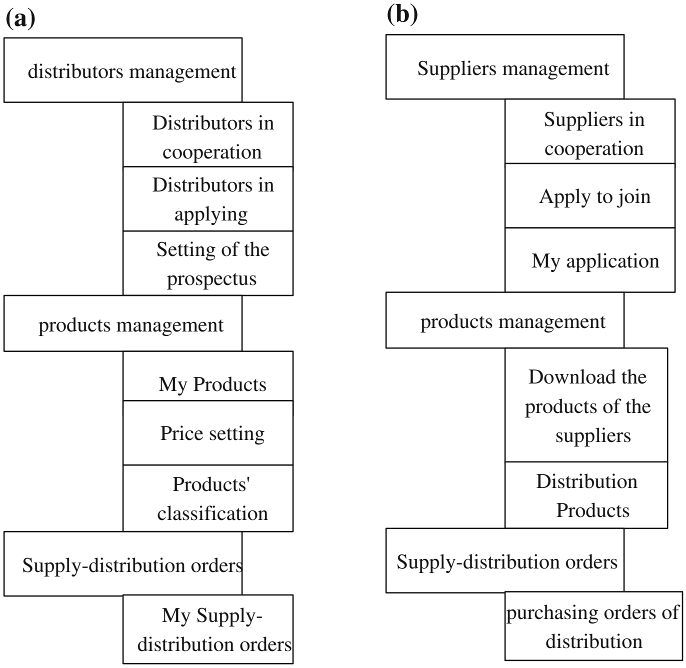

Fig. 125.2 The sketch menu of the supplier/distributor

125.5.2 Implementation of the Distributor Module

The distributor's function includes: supplier management, distribution products management and distribution orders. The sketch menu of distributor is shown in Fig. 125.2b.

125.5.3 The buyer's E-shopping Process

The buyer's e-shopping process in the distributor's cyber shop: select the products and generate order; pay to the right distributor's Alipay binding with the cyber shop; the distributor pay to the right supplier's Alipay; then the supplier deliver the products to the buyer according to the order; the buyer confirmed receiving the products, the right distributor can get the money really; after the distributor confirmed receiving the payment from the buyer, and the right supplier can get the money really.

125.6 Application Cases

We completed the development and testing of the system after finishing analysis and design of the distribution management system based on the ceramics e-business platform. The system's functions can be operated correctly. In order to open up and broaden the network distribution channel for ceramics manufacturing enterprises, we choose more than a dozen ceramics manufacturing enterprises of the registered users in the existing ceramics e-business platform after strict selecting, make students as the system's distributors. It's worth mentioning that we applied the distribution management system successfully to the college students' e-business entrepreneurship competition. Preparations for the next e-business entrepreneurship competition are in full swing.

In addition, there are some ceramics manufacturing enterprises and the ceramics marketing enterprises or individuals (distributors) of the registered users in the ceramics e-business platform becomes supply–distribution relationship after several months' launching, and among of the distributors, there are the ones who used to be the distributors of the right suppliers' in the traditional distribution channel.

125.7 Conclusion

This paper illustrates the design ideas, functions design and implementation of the distribution management system based on the ceramics e-business platform (www.ccmall.cn). The system is formally launched after developing and testing. The distribution management system opens up and broaden the network distribution channel for the ceramics manufacturing enterprises, realizes management and supervision of network distribution channel through authorizing products classification and controlling price and other methods, realizes integration of the traditional and network distribution channel through network management of traditional distribution channel; it also provides zero inventory network distribution pattern for the distributors.

The distribution management system based on the ceramics e-business platform did not take into consideration that the distributor sells the right products in the cyber shop of the ceramics e-business platform directly after the products are bought by the distributor and delivered to the distributor from the supplier. And the system did not take into consideration that the distributors develops network distributors in the system too. We can attempt to develop these functions based on the work we have done if these functions are necessary after requirement analysis and investigation.

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Chapter 126
The Impacts of Virtual Community's Online Word-of-Mouth on Consumer's Intention

Yi-ling Zhang

Abstract Based on relative studies of home and abroad, this essay made brand trust as mediator variable and established a model that online WOM have influence on buying intention, which is proved by the questionnaires of network consumers. The study has found out that the online WOM influences its receiver's brand trust and consumer's willingness of buying positively. It provides suggestions for websites on how to use WOM to make an effective marketing strategy.

Keywords Virtual community · Online WOM · Purchase intention · Brand trust

126.1 Introduction

At present, most theoretical research about online WOM concentrate on factor analysis, the comparison of traditional WOM and online WOM, the communication and motivation of online WOM at network, and the effort of it on purchase intention. In addition, there are some researches focused the regulation of various factors about the effect of online WOM on consumer purchase intention. Based on relative studies of home and abroad, this essay made brand trust as mediator variable and then established a model that online WOM have influence on consumer's purchasing intention, which is proved by the questionnaires of network consumers.

Y. Zhang (✉)
Pinghu Campus, Jiaxing University, Zhejiang, China
e-mail: zhangyiling-310@163.com

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126.2 Literature Review and Study Hypothesis

Trust in virtual community is that members of community trust the community and all kinds of interaction in the community. When shopping at network, consumers often search relative comments about the brand, product or service in order to get enough information about them to reduce the risk of buying at network. Virtual communities' trust can influence consumer's brand trust. Consequently, many researchers regard brand trust as a key during consumer making purchase decisions in the past research. Accordingly, this paper put the assumptions: virtual community trust effect on quality trust (H1a), goodwill trust (H1b) and ability trust (H1c) of brand positively.

And professional level of WOM is the reliability and accuracy of the information about a brand, product, or service. Hovland and Weiss' (1951) research result shows the higher reliability of the information, the more effective on the attitudes of consumer, the lower reliability of the information, the less effective on the attitudes of consumer. Namely, it is say that the professional level of WOM significantly impact attitudes of recipient. Therefore, this paper assumes hypothesis that professional level of WOM effect on quality trust (H2a), goodwill trust (H2b) and ability trust (H2c) positively.

Furthermore, homological level of MOW is the similarities between information recipient and massage sender in the preferences, tastes and lifestyle. The homology, among members of community, makes them more likely to accept other's views and suggestions. Gilly et al. (1998) regard homological level of information could effort information credibility. Brown et al. (2007) will also consider homological level of MOW is a cause of affecting consumers' attitude and purchase intention. And consider higher homological level of MOW can influence consumers more effectively. In the network, consumers tend to trust similar consumers and their comments (Smith et al. 2005), and high homological affect consumers' purchase intention through increasing consumers' brand Trust. Accordingly, we put hypothesizes that homological level of MOW impact on quality trust (H3a), goodwill trust (H3b) and ability trust (H3c) of brand positively in a virtual community.

When in uncertainty risk environment, consumers through meeting brand quality, and its ability which fulfills its commitments, to increase the positive expectation of product, and finally enhance the willingness of a brand. Brand trust is so-called that consumers' willingness to brand. It includes the quality of trust, goodwill trust, and ability trust of a brand (Denghua et al. 2007). The credibility of a brand is an important affecting-factor of consumers' purchasing intention. Establish a good brand trust and reputation will increase consumers' brand trust, further enhancing their purchase intention. Accordingly, this study proposes assumptions that consumer purchase intention would be effected by quality trust (H4), goodwill trust (H5) and ability trust (H6) of brand positively in network.

This paper reviews researches of the virtual community, the network WOM. And we analysis all sides of purchase intention of consumers. Then drawing on the basis of previous studies, we propose an initial model in this paper. This paper establish a initial model from the virtual community trust, professional level and Homological level three aspects to research how virtual communities play a role on consumers' purchase intention. Further, the paper discovers brand trust intermediary actions that may exist between consumers' interaction and purchase intention in virtual communities.

126.3 Methodology

The study of online shopping by consumers, the research goal is to investigate and analyze the virtual community word of mouth on the impact of online shopping population mechanism. Data for this study were collected through online and offline questionnaires approach to validate the model. Investigate lasted 4 months, 458 returned valid questionnaires were initially screened for usability and reliability from 630 responses, the percentage is 72.6 %.

In order to ensure the reliability and validity of questionnaires, this study refers to the relevant literature and on the basis of the scale used by domestic and foreign scholars, adding, considers with the development of virtual communities' WOM to modify scales to fit the context of online WOM. The references and sources of each variable in the scales for the questionnaire were provided in Table 126.1. To make sure the effectiveness of independent variables, mediating variables and outcome variables, the questionnaire was formed in three steps: first, the existing scales translation; second, expert advice collection and investigation; third, sample-validation. This test respondent was asked to indicate agreement with each statement in a measure using a 5-point scale Liken-type scale. The questionnaire consists of two parts: the first part is the description of consumers' individual characteristics with 10 questions, and the second part is to measure variables within the first research model, with 33 questions in total.

Table 126.1 Sources of scales

Variables	Original source	Reliability coefficients
1. Virtual community trust	Zeitham et al. (1996), Bansal and Voyer (2000)	0.829
2. Homological	Netemeyer and Bearden (1992), Balasubramanian et al. (2003)	0.911
3. Level professional level	Brown et al. (2007), Gilly et al. (1998)	0.891
4. Quality Trust	Denghua et al. (2007)	0.863
5. Goodwill Trust		0.841
6. Ability Trust		0.846
7. Purchase Intention	Monroe, Dodds and Grewal (Kent et al. 1991), Pavlou (2003), Schiffman and Kanuk (2000)	0.911

Table 126.2 Research variables average, reliability coefficient, and correlation coefficient

Variables	M	SD	1	2	3	4	5	6
1	3.820	0.872	1					
2	3.751	0.875	0.156**	1				
3	3.684	0.864	0.151**	0.286**	1			
4	4.003	0.879	0.366**	0.284**	0.273**	1		
5	3.998	0.863	0.405**	0.168*	0.227**	0.558**	1	
6	4.009	0.857	0.391**	0.213**	0.045*	0.463**	0.548**	1
7	3.858	0.859	0.335**	0.060**	0.050**	0.366**	0.183**	0.297**

$p^* < 0.05$, $p^{**} < 0.01$

126.4 Analysis and Results

There were two parts of our analysis. Firstly, we use factor analysis and Cronbach's α to test reliability and validity of the model. By the purification of the measuring item, analysis the survey date using SPSS13.0; the results are as follows in Table 126.2.

Secondly, the study used SEM to test the causal structure of the proposed research model. The causal structure of the research model (Fig. 126.1) was tested using SEM. 458 samples of data from respondents were analyzed using Amos 5.0 to test the SEM. The goodness-of-fit indices for this model were shown in Table 126.3 and the test demonstrated reasonable fit between the data and the proposed structure model. The results showed that not all of the parameters were significant.

χ^2/df is 1.845, this indicator fit for the statistical requirements. RMSEA is 0.043, according to Steiger's opinion (Steiger 1990), if the RMSEA is less than 0.1 indicated good fit, lower than 0.05 indicated very good fit, and lower than 0.01 indicated very beautiful fit, so this indicator fit for the statistical requirements, too. In addition, according to Bentler's advice (Bentler 1992), when the CFI ≥ 0.90, it's a great matching model as long as the GFI ≥ 0.85. Therefore, the result of the theoretical model has a very good fit (Fig. 126.2).

Fig. 126.1 Research model 1

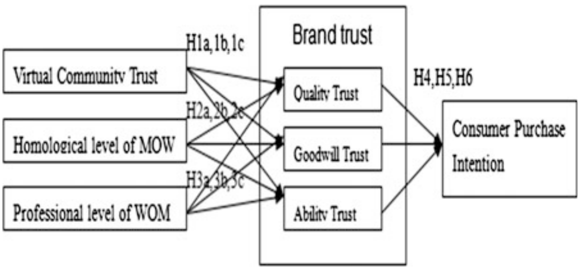
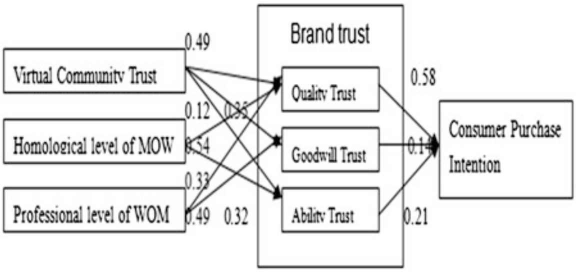


Table 126.3 Fit measures for SEM

Fit indicators	Criteria	Results
χ^2/df	<5 (Wheaton et al. 1977)	3.28
GFI	≥0.85 (Bentler 1992)	0.902
AGFI	≥0.85 (Bentler 1992)	0.870
IFI	≥0.9 (Bentler 1992)	0.916
CFI	≥0.9 (Bentler 1992)	0.915
RMSEA	<0.1 (Steiger 1990)	0.065

Fig. 126.2 Research model 2



126.5 Conclusion and Implications

To figure out the validation degree and comparison of the research model with SEM. At the same time, removing two non-significant path (professional level of WOM → goodwill trust, homological level of WOM → ability trust). Finally, we got the optimal model (Fig. 126.2). Our work generated the following research suggestions:

1. Establish brand communities to create a good community environment. Virtual communities should develop professionally, enhance the reputation in their own field and build authoritative position. Additionally, improving the community system to provide consumers with convenient, fast and reliable communication platform in the virtual communities in order that, consumers can be more effectively interact and communicate with each other and companies. In a good environment, consumers can trust each other; thereby they also trust others' comment about product, brand or service; finally, they can reduce the risk of shopping at the network through others' comment; and WOM also can further enhance the consumers' brand trust.
2. Virtual community exclusion. When companies build brand virtual or brand community Union, they should pay attach to community exclusion, that is to say, the brand community should face to target consumer group. On the one hand, the consumers, who have similar values, lifestyles, hobbies and so on, can easy to get a common topic in communication. And compared with non-similar ones, consumers tend to interact with similar consumers and also incline to trust their comments. On the other hand, enterprises can take advantage of the

exclusive community to provide particular service for consumers to improve their satisfaction, loyalty, and brand reputation.

3. Improve professional level of WOM. Companies can dig the more professional groups in virtual communities, and encourage or stimulate them to recommend products. When spreading the positive WOM about products to maximize the effect of publicity online. Companies also can culture the opinion leaders, not only to provide other consumers some reliable information on products, brands or services; but also to feedback other consumers' attitude to optimize the next round of product design and development.

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Chapter 127
A Study on the Adoption Factors of Cell Phone Video Call Technology

Bo Zhang and Hao Jin

Abstract Recent years, mobile technology has become increasingly common in today's everyday life. However, the data shows that the usage rate of cell phone video call in China is still very low. The conceptual model extend the original TAM by including subjective norm, perceived risk, perceived compatibility and consumer innovativeness, to make it more effective in predicting users' acceptance of phone video call. The empirical result analyzes the key driver of acceptance of phone video call and provides a theoretic way to raise the usage rate and efficiency of it. This research defined the barriers that obstruct phone video call diffusion in China and then it end up with recommendations for firm' decision makers, to improve phone video call in their firms, as well as recommendations for future researches with in the same scope of this research. We also hope to do some contributions to the current theoretic frame of consumer innovative actions.

Keywords Phone video call · Diffusion of innovation · Technology acceptance model · Intention to use

127.1 Introduction

Driven by the increasing mobility of today's modern society, the number of mobile phone users has significantly increased in recent years. In particular, as a key increment business of mobile operators, the countries all over the world has a positive forecast for cell video call. Cell phone video call technology has huge

B. Zhang (✉) · H. Jin
School of Management, Hebei University of Technology, Tianjin, China
e-mail: zhbo@hebut.edu.cn

H. Jin
e-mail: jbs@hebut.edu.cn

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development potential. Globally, not only Europe and the United States but also South Korea, cell video call has become increasing popularity. In contrast, since 3G network construction of China starts relatively late, the usage rate of cell phone video call is still in a very low level at present. Just a few number of China mobile consumers are using this service, while huge range of China consumers don't using it, and others not even heard of it. Thus, the actual market penetration of phone video call services deviates from previous predictions seriously.

Along with the demand for promotion and popularization of 3G technology in China, the issues that consumers how to accept or reject this business has become increasing focused and concerned by academic circles. It is quite deficiency and exigent to use systematic analysis to cell phone video calls for the country's consumer behavior and characteristics of technology adoption. In view of this, using theory and method of innovation diffusion and technology acceptance, this thesis will analyze the question of why consumers have not accept phone video call, and will study the key factors in consumers' acceptance of phone video call services, offer theory according and meaningful guide for managers how can enhance the number of customers who choose this way of communication as an alternative to more traditional communication mode effectively. For this purpose, the research extended the original TAM by including new constructs and collected 422 usable samples from a representative sample of 500 respondents. Then we used the structural equation modeling software Lisrel8.70 to test a theory-based research model of phone video call acceptance.

The outline of the current article is as follows: First, we extend the original technology acceptance model TAM, to make it more effective in predicting users' acceptance of technologies, related to mobile services in general, the acceptance of cell video call in particular in China. Based on the literature review and the preliminary study, the researcher extended the original TAM by adding some key constructs (perceived risk, perceived compatibility and consumer innovativeness). Then we present our hypotheses to find the barriers that obstruct the diffusion of phone video call in China and make Chinese customers unwilling to adopt this service, And also; to give imaginations and solutions for solving this problem.

127.2 Literature Review

In the IT/IS literature, many models have been advanced to predict users' new technology usage (Venkatesh and Davis 2000). Among them, the technology acceptance model (TAM), proposed by Davis (1989), and has evolved as the most popular. TAM has seen many applications and extensions In the IT/IS field since its development. The benefits of TAM include reliable instruments with empirical soundness, conciseness and excellent measurement properties. TAM is also applied to a wide range of research questions, including attitude toward self-service solutions (Cen and Gan 2011), wireless LAN usage (Yoon and Kim 2007), and adoption of internet banking (Lee 2009).

TAM is predictive model, but in fact it usually does not provide sufficient understanding with the necessary information to create user acceptance for new technology and services, thus; many researchers have extended the original model to make it more affective, such as perceived enjoyment in the internet, perceived critical mass in groupware usage, perceived user resources in a bulletin board system, perceived playfulness in the web context, and compatibility in a virtual store. Moreover, many extended perception variables have been added to TAM in previous studies in specific contexts.

127.3 Hypotheses

The original technology acceptance model (TAM) separated between attitude and intention to use. According to the TAM, attitude towards using a technology has a positive direct effect on intention to use (Venkatesh et al. 2003; Yang and Yoo 2004). The implied relationship is reflected by our first hypothesis:

H1: Attitude towards using phone video call has a positive direct effect on the intention to use phone video call.

According to diffusion theory, users are only willing to accept innovations which provide a unique advantage compared to existing solutions (Rogers 1995). This research adopts the definition perceived usefulness that was given by Davis; "subjective probability that using a specific application or technology will increase his or her job performance within an organization context" (Davis 1989). The original technology acceptance model (TAM), suggested that Perceived usefulness can affect users intention to use technology indirectly through its influence on attitude towards use. Hence:

H2: Perceived usefulness of phone video call has a positive direct effect on the attitude towards using phone video call.

IN the original technology acceptance model (TAM), perceived ease of use is considered as a major influence on attitude towards a technology. This influence appears clearly from the individual's evaluation of the mental effort involved in using the technology. Consequently, we incorporate perceived ease of use of phone video call in our research model. Also it has been found that perceived ease of use can influence users' perceived usefulness of the technology (Venkatesh et al. 2003). Hence:

H3: Perceived ease of use of phone video call has a positive direct effect on the attitude towards using phone video call.

H4: Perceived ease of use of phone video call has a positive direct effect on perceived usefulness of phone video call.

The original technology acceptance model (TAM), doesn't include the impact of social influence on the decision of adopting technology. Social information can influence individual innovation decisions over and above the traditional sources of influence such as individual use of the system. Thus, social pressure is also was one of the motivations which can affect technology acceptance. Venkatesh and Davis extend the original TAM by including subjective norm as an additional factor, and the empirical study found that subjective norm not only directly influence consumers' intention to use, also to consumers' assessment to it usefulness (Venkatesh et al. 2003). Accordingly, we present hypothesis:

H5: Subjective norm has a positive direct effect on the intention to use phone video call.

H6: Subjective norm has a positive direct effect on perceived usefulness of phone video call.

The external variables, which were added to the research model, can also have an impact on consumer's decision of using phone video call; perceived compatibility was found to have an impact on consumer's decision to adopt new technology. Tornatzky and Klein (1982) find perceived compatibility to be an important innovation characteristic driving consumer acceptance. Extant research shows perceived compatibility both has positive effects on the attitude toward using a technology and perceived usefulness. In view of these findings, we hypothesize the following:

H7: Perceived compatibility of phone video call has a positive direct effect on perceived usefulness of phone video call.

H8: Perceived compatibility of phone video call has a positive direct effect on the attitude towards using phone video call.

We further extend the original technology acceptance model by including the perceived risk of phone video call as an additional factor. Innovations usually come with varieties of risks (such as technical complexity, high prices, and the novelty). Huang and Chuang, based on the theories of planned behavior (TPB), make perceived risk as a new variables influencing innovation adoption, and the results show that the effect is remarkable (Huang and Chuang 2007). Lwin et al. (2007), Chen (2008), Kim et al. (2010) also found the perceived risk of consumers and the attitude towards using unknown technical products has an obvious negative correlation, and proved by empirical evidences. Hence:

H9: Perceived risk of phone video call has a negative direct effect on the attitude towards using phone video call.

Innovation diffusion theory suggests that the early adopters and later adopters are different in personality traits and character. Some studies hold it as a general individual personality, and define this potential tendency to accept new products as consumer innovativeness. Therefore consumer innovativeness will have a strong effect on their adopting to any new technology. Steenkamp and Gielens (2003), Zhang et al. (2009) and Chen et al. (2010)'s empirical studies found that

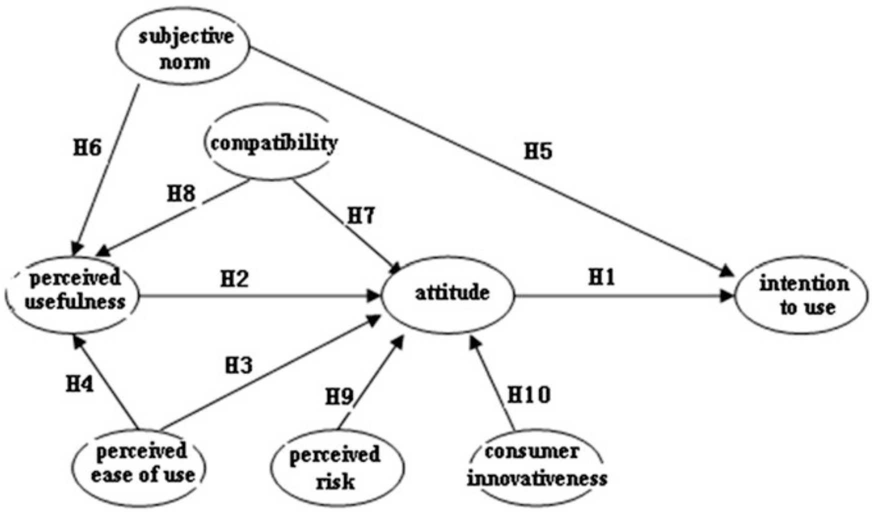

Fig. 127.1 Conceptual model

consumers' consumer innovativeness have a certain promotion effects on their attitude towards using innovation. Thus, we present hypothesis:

H10: Consumer innovativeness has a positive direct effect on the attitude towards using phone video call.

The consumer acceptance model appears in Fig. 127.1.

127.4 Survey and Data Analysis

127.4.1 Survey

The survey was conducted using a standardized questionnaire, and there were a total of 28 measurement items in the questionnaire of the survey. For the research questionnaire, the researcher choose a five-point Likert scale and the codes from 1 ("quite disagree") to 5 ("quite agree"). Table 127.1 provides a list of all measurement items and their sources. To collect the quantitative data for this research, 500 persons were randomly chosen to fill the questionnaire survey. At the end of the data collection period, 422 usable samples were received, with 225 female and 197 male. Of these samples, 43.4 % were in their late twenties, 31.8 % were 30–39 years old, 16.4 % were 40–49, and 8.4 % were over 50.

Table 127.1 Measurement items

Construct	References	Items
Intention to use	Davis (1989)	I'm using or planning to use phone video call recently.
	Venkatesh and Davis (2000)	Given the opportunity, I will use phone video call.
		In the near future, I am willing to more use phone video call.
Attitude towards use	Van der Heijden (2003)	Using phone video call is a good idea.
	Yang and Yoo (2004)	Using phone video call is a wise choice.
		In general, using phone video call is beneficial.
Perceived usefulness	Van der Heijden (2003)	Using phone video call can shorten the distance between I and others.
		Using phone video call makes my communication become easier.
		Using phone video call makes my communication become more fun.
		In general, phone video call is a useful communication technology.
Perceived ease of use	Venkatesh and Davis (2000)	It is easy to become skillful at using phone video call.
		The interaction with phone video call is clear and understandable.
		It is easy to perform the steps required to use phone video call.
		In general, phone video call is a technology that easy to master.
Subjective norm	Venkatesh and Davis (2000)	People who are important to me would recommend using phone video call.
		People who are important to me would find using phone video call beneficial.
		People who are important to me would find using phone video call a good idea.
Perceived compatibility	Plouffe et al. (2001)	Using phone video call fits well with my lifestyle.
		Using phone video call fits well with my past experience.
		In general, phone video call fits well with my current need of communication.
Perceived risk	Luarn and Lin (2005)	I worry about that using phone video call may leak my privacy.
		I worry about that using phone video call may lead to high costs.
		I worry about that the network is instability, may be disrupted when communication.
		Using phone video call leads me to some degree of tension and worry.
Consumer innovativeness	Hynes and Lo (2006)	I am willing to try new things in life.
		I like to accept challenges from new things; even it would worth my time and effort.
		I think new lifestyle and ways of consumption is a progress to the past.
		When the new product or technology appearance, I usually to be the earlier adopter.

127.4.2 Reliability and Validity Analysis

After survey we used Crobach alpha with SPSS18.0 software to make reliability analysis. In this research the reliability test was used to examine the consistency with which individuals respond to the test in diverse occasions. We first conducted analyses separately for each factor and calculated coefficient alphas, composite reliabilities, and corrected Item—total correlation (CITC). Table 127.2 provides the detailed description of the scales used to measure each of the variables. Crobach alpha for all research variables are greater than 0.6; composite reliabilities are exceed the recommended threshold of 0.7; and corrected Item—total correlation values ranged from 0.464 to 0.823. From these results it is conclude that the scales have high levels of internal consistency, and are considered to be suitably reliable.

In addition, we assess measurement validity through the content validity and structural validity. The whole scale is developed based on the mature scale of prior studies, so it has already had good content validity itself. We conducted a confirmatory factor analysis (CFA) using Lisrel8.70 to assess structural validity of the measurement. All the constructs were measured with multiple indicators. If a factor's loading is lower than 0.4 or its T value is lower than 1.95, the factor will be eliminated. The results showed that the size of each factor loading ranged from 0.52 to 0.91 and the T values for those indicators ranged from 7.58 to 19.15. Table 127.2 shows the results of the test and factor loading items of all the variables. Overall, we conclude that all the items of the questionnaire are accepted in the final study.

127.4.3 Structural Equation Model Analysis

Previous table illustrates that the tolerance values for all dimensions were accepted, the next step was to examine the structural model. The overall fit indices of the structural model were within the range that scholars generally recommend. The ratio of Chi square to degrees of freedom was 1.632, which met the recommended criteria of less than 3. The goodness of fit index (GFI) and adjusted goodness of fit index (AGFI) were 0.90 and 0.88, respectively. The normed fit index (NFI) and comparative fit index (CFI) were 0.93 and 0.98, respectively. The standard root mean square residual (SRMR) and root mean square error of approximation (RMSEA) was 0.43 and 0.36. A comparison of these values against those recommended in the literature suggests that the model estimation result is quite satisfactory. Figure 127.2 summarizes the estimation results and shows the relationships among constructs that are statistically significant.

Table 127.2 Reliability and validity analysis

Construct	Items	Cronbach alpha	Loadings	T-value
Intention to use	IN1	0.784	0.74	13.65
	IN2		0.83	16.10
	IN3		0.66	11.81
Attitude towards use	AT1	0.825	0.80	15.35
	AT2		0.74	13.91
	AT3		0.81	15.74
Perceived usefulness	PU1	0.839	0.68	12.47
	PU2		0.67	12.08
	PU3		0.76	14.44
	PU4		0.91	18.62
Perceived ease of use	PE1	0.888	0.78	15.26
	PE2		0.78	15.23
	PE3		0.79	15.45
	PE4		0.91	19.15
Subjective norm	SN1	0.689	0.54	7.85
	SN2		0.52	7.58
	SN3		0.65	9.34
Perceived compatibility	PC1	0.797	0.57	8.92
	PC2		0.71	11.08
	PC3		0.68	10.57
Perceived risk	PR1	0.864	0.79	15.05
	PR2		0.77	14.69
	PR3		0.81	15.61
	PR4		0.77	14.65
Consumer innovativeness	CI1	0.839	0.76	14.27
	CI2		0.62	10.89
	CI3		0.89	17.77
	CI4		0.75	14.08

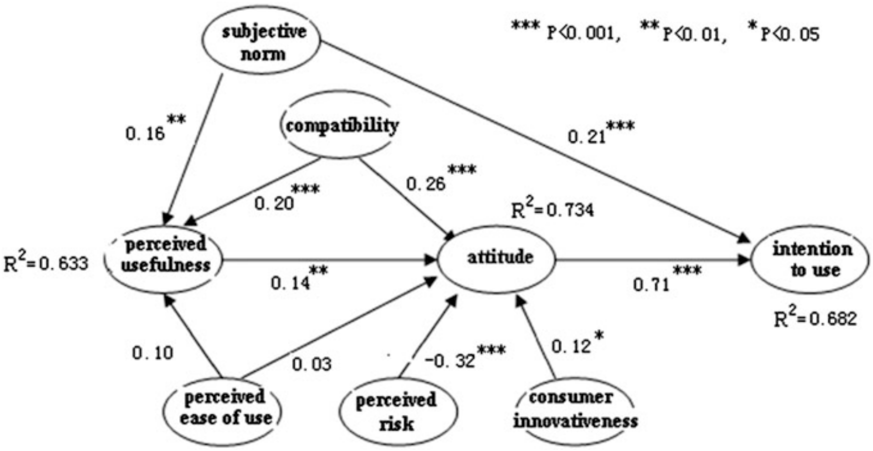

Fig. 127.2 Results of model estimation

127.5 Results

We found support for H1, attitude has a significant and positive relationship with the intention to use phone video call ($b = 0.71$; $p \leq 0.001$). Moreover, the path coefficient of 0.14, significant at a 1 % level, points to perceived usefulness has a strong positive relationship with the attitude towards using phone video call, as proposed in H2. Further, structural links from perceived ease of use to the attitude ($b = 0.03$; $p > 0$ 0.05) and from perceived ease of use to the perceived usefulness ($b = 0.10$; $p > 0.05$) are not significant. Thus, H3 and H4 were rejected. In addition, the relationship proposed in H5 and H6 are confirmed; that is, subjective norm has positive effects to the intention to use phone video call ($b = 0.21$; $p \leq 0.001$) and the perceived usefulness ($b = 0.16$; $p \leq 0.01$). The results also provide strong evidence for the effects of perceived compatibility on the attitude ($b = 0.26$; $p \leq 0.001$) and the perceived usefulness ($b = 0.20$; $p \leq 0.001$), in support of H7 and H8. Regarding the perceived risk factor, we found a significant link with the attitude ($b = -0.32$; $p \leq 0.001$), implying that the perceived risk has a strong negative effect on attitude towards using phone video call. Therefore, H9 is confirmed. In the end, the construct of consumer innovativeness has a significant relationship with the constructs of attitude ($b = 0.12$; $p \leq 0.05$). Thus, H10 is supported. In the entire model for all predictors, R2 explains 68.2 % of the variance related to intention to use phone video call, indicating that the model highlights a comprehensive set of important factors that are associated with consumer acceptance.

In order to examine the total effects and establish a ranking among the drivers of phone video call acceptance, we multiply the coefficients along the paths (Table 127.3) (Bollen 1987). For example, the total effect of compatibility on intention to use equals the indirect effect via perceived usefulness plus the indirect effect via attitude towards use ($0.20 * 0.14 * 0.71 + 0.26 * 0.71 = 0.20$).

Table 127.3 Total effect on intention to use

Factor	Total effect on intention to use
Subjective norm	0.23
Perceived risk	−0.23
Perceived compatibility	0.20
Perceived usefulness	0.10
Consumer innovativeness	0.08
Perceived ease of use	0

127.6 Discussion

The research presents a powerful model to predict technology acceptance and recognizes that there are many factors that could affect the success and effectiveness of phone video call in developing countries. The empirical study found that subjective norm and perceived risk have the greatest impact on the intention to use phone video call. It is important since both perceived risk and subjective norm are not part of the original technology acceptance model and thus are often not considered by researchers. The same is true for the factor perceived compatibility.

The six factors summarized in Table 127.3 can serve as a guideline for increasing further market penetration of phone video call services. The impact of subjective norm was found to be very important in the research model. It can be implied that firms need to identify early adopters and stimulate their usage of phone video call services, so that they can serve as a reference facilitating broad diffusion in the future. Perceived risk is another key factor of the consumer acceptance of phone video call. Thus, firms need to increase the security of using phone video call by using the most developed technology in this field,besides improving this services focused on charges, communication performance and privacy protection when promoting it. The research which was conducted by supports in explaining a part of the rest whereas it explains 20 % of the variance of consumers' perceived compatibility of using phone video call in developing countries. Thus, firms should develop phone video call technology and solutions that make consumers regard it as well-suited to their individual behavioral patterns. Similarly, perceived usefulness and consumer innovativeness also of "some concern" for affects effects on access of using phone video call, so firms can use the way of advertise to make users know more about the benefits and joy of this service, thereby increasing consumers' cognitive of usefulness and Cause interests of potential consumers.

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Chapter 128
The Research on Scheduling Model of Online Service in Electronic Commerce: Perspective of the Service Profit Chain

Mi-yuan Shan, Xue-lin Zhou and Ren-long Zhang

Abstract The emergence of electronic commerce (e-commerce) has changed the consumption concept of customers. They usually pay more attention to the customer service quality of Network platform apart from the convenience and risk of shopping environment. With the characteristics of virtuality and information sharing under the e-commerce environment, buyers and sellers cannot contact face to face. It makes enterprises a lot of difficulties such as low customer satisfaction, lack of loyalty and weak profitability following the communication barrier. This paper first applies the theory of Service Profit Chain (SPC) to solve the problem of online service scheduling in e-commerce and establishes a mathematical model in which the whole customers' service value can be maximized. Then via numerical test, we verified the effectiveness and feasibility of the model. The results show that this research has good practicability and generalization for improving customer satisfaction in e-commerce.

Keywords Electronic commerce · Online service · Scheduling model · Service profit chain · Service value

128.1 Introduction

The homogenization of products and technology innovation intensifies the fierce competition for market share of electronic commerce (e-commerce) businesses thus force them to focus on online service management. However, it is a common phenomenon that service resource shortages, low efficiency and effectiveness of services, and poor responsibility often occur in the existing e-commerce platforms,

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M. Shan · X. Zhou (✉) · R. Zhang
School of Business Administration, Hunan University, Changsha, China
e-mail: zhouxuelin0309@163.com

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the above defects of online service management may lead to a loss of customers due to the dissatisfaction. This affects the profitability of enterprises severely.

Current researches on customer satisfaction focus on the integration and innovation of customer service mode, service strategies optimization in e-commerce, papers considering the issue of online service scheduling are still rare. Xu (2002) made detailed analysis about the progress of customer service and incisively summarized the suggestions to improve service management that enterprises should equip some service auxiliary tools to support service measures. Wei (2004) formulated the service strategies of pre-sale, sale and after-sale stages to improve customer satisfaction and customer loyalty. Fang (2010) studied the customer service center of network platform. Firstly he analyzed the existing problems and weaknesses, on the basis he set up the structure of service center and reviewed the functional module and business flow. Although the elements were systematic and comprehensive, the model was still a conceptual one and lack of optimization approaches. Liu et al. (2008) Zeng presented a model of Customer Satisfaction Index in e-commerce using fuzzy techniques to evaluate the quality of service. The paper did not suggest how to improve customer satisfaction. In recent years, foreign researchers have achieved some success. Lee and Park (2009) studied on the classification of e-commerce service and the strategic management based on customers' perception. For the purpose, online services were identified from Korean Portal Sites and classified by 11 variables representing customer perceptions about service characteristics in the e-commerce context. Udo et al. (2010) examined the dimensions of web service quality based on e-customers' expectations and perceptions after that they developed operational web service quality construction, and analyzed their relationships between customer satisfaction and behavioral intentions in an e-business environment. The research showed that the direct cause influencing customer satisfaction was the contact progress of online service in e-commerce. So studies on e-commerce service system have important significance in-depth. Basic queueing systems involve organized queues where units are dealt with according to their order of arrival (Pardo et al. 2007). Nonetheless, this traditional first-come first-served rule isn't applied to the service strategy in improving customer satisfaction; we should seek a new service rule on customer priorities to optimize the combination order which contribute the improvement of e-commerce's customer satisfaction. With regret, there is no one submitting an effective intelligent optimization model to solve the online service scheduling because of the limitations of previous studies.

As there is much room for improvement for the theories and methods in online service scheduling, we will introduced the theory of Service Profit Chain (SPC) into the customer services management, and design a scheduling model based on the customer value equation in order to help enterprises improve the customer satisfaction and achieve sustained profits. We hope to provide reference and guidance for e-commerce's online service management.

128.2 Theory of Service-Profit Chain

The theory of SPC was put forward by James L. Heskett and so on in 1997 (Heskett et al. 1994). After integrating the Strategic Services theory and the relationship between customer loyalty and employee loyalty as well as corporate profits (Heskett 1986; Schlesinger and Zomitsky 1991), SPC systematically describes the circular relationship with enterprises, customers, employees and profits. The logical connotation is described as: growing enterprise profit and rising profitability mainly come from the improvement of customer loyalty; customer loyalty is the direct result of customer satisfaction and the satisfaction degree depends on the perceptive service value which is created by the staff; in the end the internal service quality determines their satisfaction. The structure of SPC is shown as Fig. 128.1.

There are two circles, one is staff circle, the other one is customer circle that are linked up by delivery services (i.e., service value equation). The entire dynamic interaction process of service value delivering is the key to service, called "service encounter". American scholar Keaveney conducted a survey of 838 cases leading the customers to choose competitors in e-commerce (Zhang and Pangpan 2009). The results found that the failure of service encounter is the second reason after a critical service mistake, accounting for 34 %, other reasons including deception, unfair pricing, service failure dissatisfaction. These findings are in accordance with Godwin J.Udo that the customers' satisfaction depends on the online service in e-commerce. Enterprises should pay attention to the value of delivery services

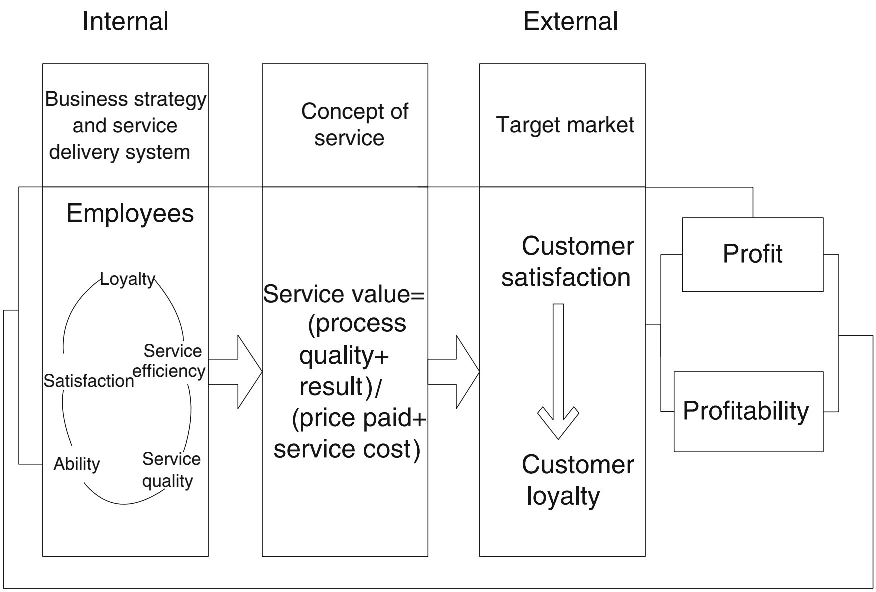

Fig. 128.1 The service-profit chain

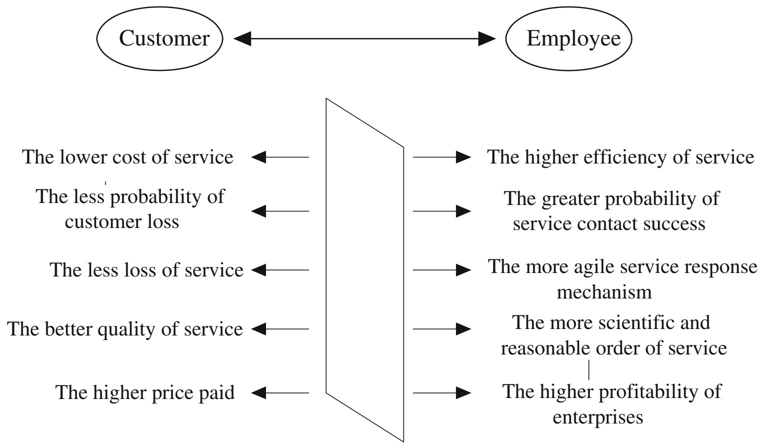

Fig. 128.2 The mapping relationship of online service value in e-commerce

during the service encounter that passed to customers for each service process, so it can experience the high-quality service, the higher the value of services the more satisfaction, thus the enterprises will gain more profits. After reviewing the theory of SPC, this paper proposes a mapping model of online service value based on the characteristics of e-commerce and online service factors as Fig. 128.2.

The SPC theory is very useful to solve online service scheduling problem for e-commerce enterprises which gives important enlightenment. The service value equation directly affects customers' conversion in the state of satisfaction and dissatisfaction. This suggests that enterprises must give full play to the regulatory role of the service value equation. If e-commerce enterprises provide customers with the greater value of services, the more satisfaction customers gaining, there must be a higher profit value generated for enterprises. Therefore, this paper designs a scheduling model of e-commerce's online service from the perspective of SPC to improve customer satisfaction.

128.3 Model Building of E-Commerce Online-Service Sorting

128.3.1 Problem Description

Many service systems require customers to make an appointment prior to receiving service (Creemers 2009). In a period of time, service requests of customers on the platform form the tasks of online service personnel. Call center must allocate reasonable tasks to the online service staff as soon as possible under the condition of limited resources in order to meet the need of customers. The expression of

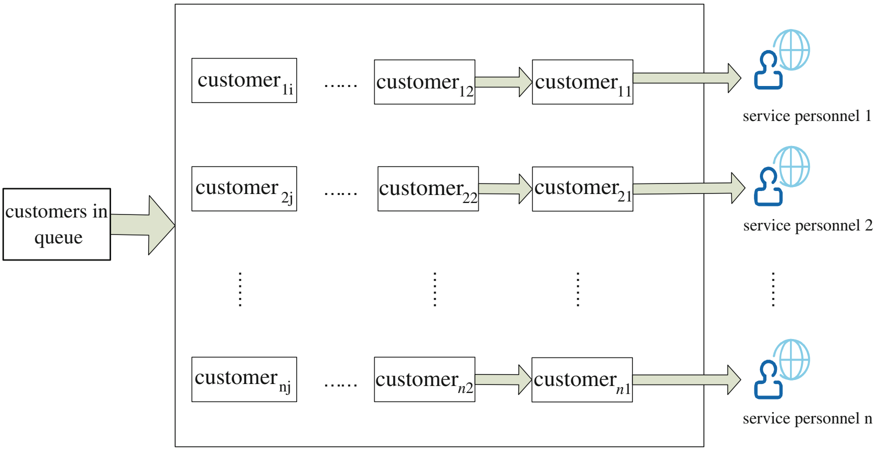

Fig. 128.3 The expression of service sorting

service scheduling is shown as Fig. 128.3. Customer service scheduling must pay attention to the value of services for customers. Improving the whole value of services will be able to improve customer satisfaction from an overall point. So we can select different customer service staff and optimize the combination of customers' order to maximize the service value of all customers in a specified period of time. The following from resources environment, the action mechanism, target of online service scheduling to describe the operation of e-commerce online customer service.

1. *Resources environment*: In general, in order to meet the different scales of customers, the call center requires a certain number of online service personnel at the same time whose efficiencies are different to handle the requests for the purpose of realizing the parallel service assignments.
2. *Action mechanism*: The service value is constrained by transaction cost, service process quality and the results. We try to introduce the service value equation into the scheduling model to make the integration of the SPC and the service scheduling management method. The aim of customer satisfaction maximization promotes more customers to be satisfied also reduces the cases of customer dissatisfaction.
3. *Target of online customer service scheduling*: In the process of online service encounter, efficient and agile service channel and response rate can improve the quality of service. If customers do not get services in their acceptable time, it will cause hysteresis loss denoted by T_{ij} which greatly affects the quality of service. T_{ij} and α_i have obvious decreasing correlation. α_i represents the service outcome and process quality for one customer. Equally, α_i can be expressed by T_{ij}, the greater α_i the smaller T_{ij}. Meanwhile, the time cost and service price β_i is directly reflected in transaction price P_i and hysteresis cost $a_j \cdot T_{ij}$, the importance of transaction relies on the client himself. All the factors of the

service value equation and T_{ij} establish a quantitative relationship. The purpose of online service scheduling is maximizing the service value $\sum \alpha_i / \beta_i$ of overall customers in a waiting time.

128.3.2 Mode Hypotheses

1. One service request corresponds to one customer;
2. All the online service staff are vacant at initial moment;
3. The service personnel handle the requests submitted during the same period, and each customer's service waiting time is limited. Beyond the waiting time it means hysteretic and affects the service value;
4. Each customer can't accept multiple clients' service requests simultaneously. Only when one online service personnel finishes the task for a specific customer he or she can continue to the next task and each service process is not allowed to interrupt;

128.3.3 Parameters and Variables Description

α_i the service outcomes and process quality for each customer;
β_i the time cost and transaction price;
m the quantity of service requests at a specific moment;
i the number of service requests;
n the quantity of online service personnel;
j the number of online service personnel;
S_{ij} the beginning time of online service personnel j handling service request i;
T_{ij} the delay time of online service personnel j handling service request i;
d_i the waiting time of customer i acceptable;
P_i the transaction price of customer i;
a_j the unit time cost of delay for online service employee j;
$x_{(t)ij}$ 0 or 1, online service personnel j provides service for customer i at time t

128.3.4 Model Construction

Objective function:

$$f = \max \sum_{i=1}^{m} \frac{\alpha_i}{\beta_i} \tag{128.1}$$

Constraints:

$$T_{ij} = \max[(S_{ij} - d_i) \cdot x_{(t)ij}, 0] \quad i \in M, M = \{1, 2, \cdots, m\} \text{ and } x_{(t)ij} = 1$$

$$\alpha_i = \frac{1}{\sum_{t=0}^{S_{\max}} \sum_{j=1}^{n} T_{ij} \cdot x_{(t)ij} + 1} \tag{128.2}$$

$$i \in M \tag{128.3}$$

$$\beta_i = P_i + \sum_{t=0}^{S_{\max}} \sum_{j=1}^{n} a_j \cdot T_{ij} \cdot x_{(t)ij} \quad i \in M \tag{128.4}$$

$$\sum_{t=0}^{S_{\max}} \sum_{j=1}^{n} x_{(t)ij} = 1 \qquad i \in M \tag{128.5}$$

$$\sum_{t=0}^{S_{\max}} \sum_{i=1}^{m} \sum_{j=1}^{n} x_{(t)ij} = m \tag{128.6}$$

$$x_{(t)ij} \in \{0, 1\} \quad i \in M; j \in N, N = \{1, 2, \ldots, n\} \tag{128.7}$$

From the general perspective of enhancing customers' satisfaction, the objective function (128.1) denotes that the goal of online service scheduling model is to maximize overall customers' service value. When the objective value is a maximum, all the values equaling to 1 are the optimal combination results of customer service scheduling.

The constraint condition (128.2) denotes the delay time of online service personnel j handling service request i. In the equation, $x_{(t)ij} = 1$ fixes on the service task which customer i is assigned to service personnel j. If the time when customer service personnel j receive the request of customer i exceeds the acceptable waiting time, the service delays and the value of T_{ij} is equal to the difference of service beginning time and waiting time. If within the customer's expectation, the service doesn't delay and the value of T_{ij} is 0.

The constraint condition (128.3) represents that T_{ij} measures the service outcome and process quality α_i for customer i. The longer T_{ij}, the smaller α_i.

The constraint condition (128.4) denotes each customer's transaction price and time cost due to service delay.

The constraint condition (128.5) ensures that a specific customer can only be one customer service personnel service once, which $S_{\max}$ says the beginning time of service for the last one, $x_{(t)i1}, x_{(t)i2}, \cdots, x_{(t)in}$ only one value is 1, all the rest are 0.

The constraint condition (128.6) ensure that all customers have access to services, the amount equal to the total number of m.

The constraint condition (128.7) gives the range of decision variables $x_{(t)ij}$, when $x_{(t)ij} = 1$, it suggests that online-service employee j services customer i at time t, otherwise 0.

128.4 Numeric Experiments

In this section we take the following four groups of problem size (m, n) to compare the performance of the scheduling model. The testing parameters are randomly generated for each problem size. Each transaction price requested by the corresponding customer service obeys uniform distribution in the interval [25, 150]; the service beginning time S_{ij} obeys uniform distribution in the interval [0, 10]; and the acceptable waiting time d_i for the waiting customer obeys uniform distribution in the interval [3, 10]. Each unit time cost a_j (unit: RMB/time) of lag service by the corresponding service personnel is set to be 1, 2,…, n respectively. To avoid each customer service staff have different beginning time, the initial time of service task received by all service staff are set to 0.

All of the scheduling model are implemented by Matlab language, and were run on a PC with Windows XP system, where CPU is 1.60 GHz and the memory is 2 GB. In Table 128.1, for each problem size, we report the optimal solution, the worst solution, the average value and the calculation number of the optimal solution based on their average values of 10 repeated tests, and in Table 128.2, we show the optimal outcome for each problem size (Figs. 128.4, 128.5, 128.6, 128.7).

The above Gantt charts show the optimal combination result for each problem size. Such results guarantee that the model can obtain a general service with maximum value. The horizontal results show the special order of a number of customers assigned to each customer service personnel, and the length of stripes denotes the length of time, which implies that each customer has different service duration. Especially, the first Gantt chart shows that for the case of $(m, n) = (10, 4)$, the fourth customer service staff is free, which implies that he is not assigned any tasks.

In this experiment, the results of solving the model appear to be reasonable and reliable, except for the first case, that is, one customer service personnel is not assigned any tasks, but other's task distribution is more evenly distributed. These shows that the optimal results can be a reasonable allocation of resources, avoid waste of resources, and each customer service personnel has clear division of

Table 128.1 Statistical analysis of test results

Problem size	The optimal solution	The worst solution	Average value	Number
(10 ,4)	0.0651	0.0185	0.03419	7
(30, 4)	0.1273	0.0635	0.09717	5
(20, 5)	0.1172	0.0508	0.06602	5
(40, 5)	0.1663	0.0917	0.12295	4

Table 128.2 The optimal sort results

Results				
j	(10, 4)	(30, 4)	(20, 5)	(40, 5)
1	7, 4, 6	7, 28, 17, 4	15, 11, 5	3, 37, 29, 1, 6, 26, 38
2	3, 9, 2, 1	27, 22, 23, 26, 14, 18, 13, 11, 5, 24	17, 19, 2	4, 28, 25, 9, 35, 16, 8, 24, 30, 21
3	5, 10, 8	19, 9, 10, 16, 6, 2, 25, 8, 20, 15, 1	7, 20, 8, 4	13, 27, 23, 36, 7, 15
4		21, 29, 3, 30, 12	10, 16, 1, 9, 18	2, 34, 22, 20, 14, 12, 33, 17, 11, 10, 5
5			5, 14, 12, 3, 13	40, 31, 18, 19, 39, 32

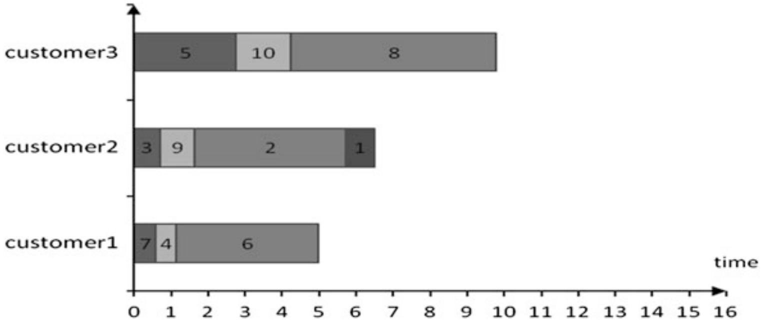

Fig. 128.4 The Gantt chart of problem size (10, 4)

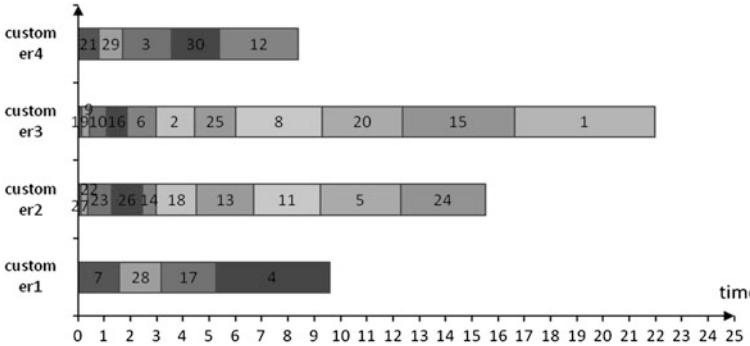

Fig. 128.5 The Gantt chart of problem size (30, 4)

labor. In specific, as the customer number increase, the objective function value under the corresponding problem size increases approximately vs. the number of customers, while the calculation number of optimal solution decreases as the number increase. It may be explained by that as the increase of customer number,

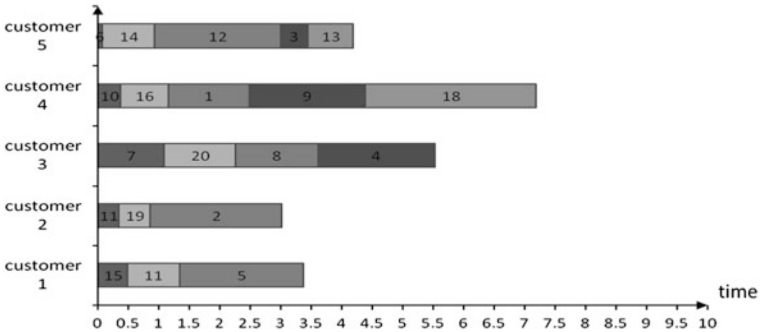

Fig. 128.6 The Gantt chart of problem size (20, 5)

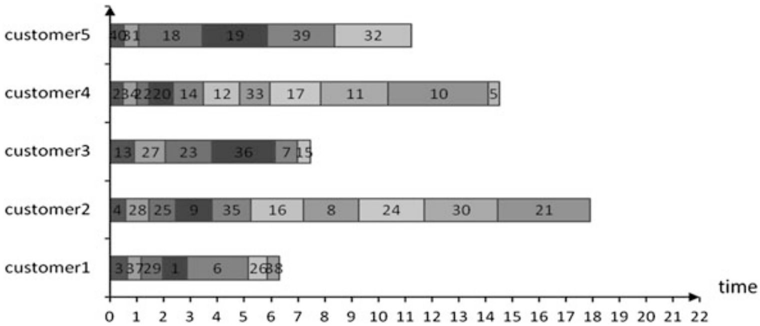

Fig. 128.7 The Gantt chart of problem size (40, 5)

the computational complexity of the solving the model is also increase, but this also can be accepted.

In conclusion, the model could be used to solve the e-commerce online customer service scheduling problem in a certain data scale, and the results of the model have certain validity and feasibility. Optimal customer service scheduling combination for improving customer satisfaction has a certain reference value.

128.5 Conclusion

Due to the significance both in real world and theory, scheduling has always been an important branch in the research of combinatorial optimization. The paper attempts to study the online service scheduling problem in e-commerce and apply the SPC theory to the circumstance for the purpose of improving and perfecting the management of online service. With maximizing the whole customers' service value as goal, we have designed the model. Then the validity and applicability of the model have been verified by taking a numerical example. Therefore, the scheduling model research of online service has both theoretical and practical significance in improving customer satisfaction to e-commerce enterprises. Above work provided a foundation for further studies into online service scheduling. However, the scheduling model in the paper only considered the best combination of stable quantity and scale in a closed state, but ignored that the number of customers' service request is dynamic in the situation of real world. Therefore, further research will continue to enrich the variables and parameters for establishing a more realistic scheduling model and utilize a new algorithm to enhance the effectiveness and robustness of model by improving the solution speed.

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Chapter 129
A Study of the Network Externality Effects on the Online Group Buying

Zhenli Bi and Bin Shi

Abstract The main features of group-buying are: businesses exchange for consumer flow and exposure with low prices, i.e. Group-Buy websites attracts consumers with low prices, and so consumers participate in online shopping due to the low prices. In this pattern, the network externality effect is magnified and becomes the main factor to draw consumers to participate in the online purchase. This empirical study reveals the mechanism of the network externality effects on the willingness to participate in the online group buying. The results of the study indicate that network externalities have no direct effect on the willingness to participate in online Group-Buy, but the indirect effect has been revealed. Furthermore, the indirect effect performs its functions by affecting the participants' trust in Group-Buy websites and affecting the consumers' cognition of discounts.

Keywords Discount · Externality · Online group buying · Price trust · Willingness to buy

129.1 Introduction

A distinguishing feature of the Group-Buy business model is that the traditional quantity discount model is overlaid with a coordination problem among consumers. The pure coordination problem occurs when all players optimize a

Z. Bi (✉)
Guangdong University of Education, Guangzhou, People's Republic of China
e-mail: zhenlibi@126.com

B. Shi
School of Management, Shenzhen Polytechnic, Shenzhen, People's Republic of China
e-mail: shib1972@126.com

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common objective function; in this case, the players are said to be a team. Clearly, the customers under Group-Buy are not operating as a team; they maximize their expected individual surpluses from their purchases. However, each consumer's behavior (whether bidding or not bidding, and the timing of the bid) affects other consumers' surplus. Thus, the problem of the Group-Buy is relevant to externalities. The network externalities will enable us to gain insights into the performance and mechanics of group-buying. The aim of this study is to prove the externality effects on the consumer's purchase decision and how the externality effects work.

129.2 Literature Review and Hypotheses

129.2.1 Discount

The key to the online group-buying is the aggregation of geographically dispersed consumer purchasing power from all over the countries that have a common interest in a certain product and come together on the group-buying-sites to get discounts (Callow and Lerman 2003). In attending online group buying not only has competitive advantages of quantity system price and delivery service, but also cooperates and shares shopping experiences with netizens. The web-based group-buying mechanisms, a refinement of quantity discounting, are being used for both B2B and B2C transactions (Callow and Lerman 2003). If the buyers with similar product or service requirements can form a virtual coalition to bargain collectively with the sellers, it can reduce the transaction cost of each side. Therefore, the first hypothesis is proposed (Anand 2003).

H1: The cognition of discount has positive effects on the willingness to participate in online group buying.

129.2.2 Trust in Online Group Buying Context

Different researches gave different descriptions for the online trust. Kim and Benbasat (2003) identified four categories of trust related issues: "personal information, product quality and price, customer service, and store presence". In the case of e-commerce shopping, Ang et al. (2001) built three dimensions of trust which improve the perception of trust on the internet. The three dimensions include the ability of the online merchant to deliver a product or service that performs as promised, the willingness of the online merchant to rectify should the purchase not meet the customer's satisfaction, and the presence of a privacy policy or statement on the web site. The researchers built the theoretical framework of online trust, covering the different stages that a consumer went through to complete an online transaction. Lee and Kim (1999) proposed that consumer could perceive trust before, during, or after the online transaction, furthermore, the researchers emphasized that different determinants of trust were associated with different stages of the transaction. According to the statement above, we can see that the different divisions of online trust are similar and overlapped in some extent.

Lee and Turban (2001) point out that trust is an important factor in the uncertain and risky environment, and consumer's purchase decision is based on the trust on vendor, which also explains the importance of trust for online transactions. Grazioli and Wang (2001) found that perceived risk and trust determine the consumer's attitude toward online purchase, which subsequently affected willingness to purchase and actual purchase behavior. Based on the discussed above, this study supposes that the better initiator's reputation is perceived by customers, the higher trust on the initiator will be created. Thus the second hypothesis is proposed.

H2: The perception of trust in Group-Buy websites has positive effects on the willingness to participate in online Group-Buy.

129.2.3 Demand Externalities

Network Externalities are a special kind of externalities in which people's utility for a goods depends on the number of other people who consume this goods. Kauffman and Wang (2002) posited that the presence of network effects in group-buying auctions will have beneficial consequences. Consumers will express a greater willingness-to-bid in a group-buying auction as more bids arrive and greater consumer participation ensues. In all of these network settings, positive network effects arise due to the fact that network participants' utility increases with the number of other users. It typically will influence consumer decision-making as well. So in the online group-buying auction context, the more people that are willing to participate by making a bid on a given product, the more value the auction will be perceived to have by the seller and the buyers. The participants' willingness-to-bid will increase due to their perception that the auction will succeed. Hence, the following three hypotheses are proposed.

H3: Demand externalities have positive effects on the cognition of the group buying discounts.

H4: Externalities have directly positive effects on the willingness to participate in online Group-Buy.

H5: Demand externalities, through the cognition of discounts, have indirectly positive effects on the willingness to participate in online Group-Buy.

Yang and Lai (2006) probed the factors affecting participants' trust in the online Group-Buy organizers and their willingness to participate in online Group-Buy, taking the number of Group-Buy participants as the independent variable.

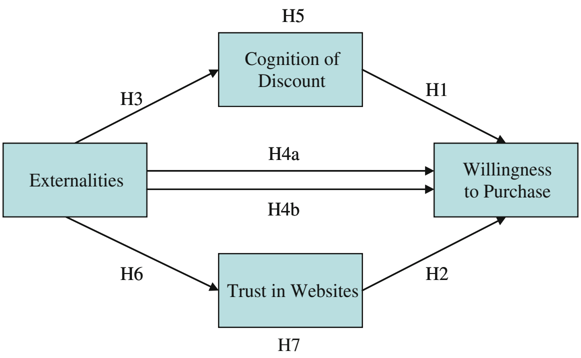

Fig. 129.1 Conceptual model

Their research suggests that the more people who participate in the Group-Buy, the more the consumers trust the online Group-Buy organizers, further, the more actively the consumers participate in Group-Buy. Thus, the conclusion can be drawn that the demand externalities have positive effects on the consumer's purchase decision. Dybvig and Spatt (1983) proved in their study that Network externalities in the form of current installed base and expected installed base are important factors influencing a potential adopter's decision to select a product. Based on the above review, another two hypotheses are proposed.

H6: Demand externalities have positive effects on the perception of trust in Group-Buy websites.

H7: Externalities, through the perception of trust in Group-Buy websites, have indirectly positive effects on the willingness to participate in online Group-Buy.

129.2.4 Conceptual Model

In the light of the above analysis, the hypothesis of the study is proposed that the causes or premises for consumer's willingness to participate in online Group-Buy or to purchase, are demand externalities, the magnitude of the discounts and the consumer's trust in the Group-Buy websites. Model 1 (see Fig. 129.1) unfolds the relations of the variables (the causes).

129.3 Research Design and Data Collection

129.3.1 Questionnaire Design

The questionnaire consists of four sections. Section 1 involves only one filterable question by which the respondents are to be identified. The question is whether the respondents have done online shopping. Section 2 is about the resources that the respondents use for online shopping, including websites and the categories of the items they bought. Section 3 is the scale designed on the basis of this research constructs. Section 4 is about the classified information including age, gender and occupation of the respondents. Four constructs are involved in the concept model, and there are four corresponding scales with four constructs respectively. What's more, four measurements for the four constructs are designed according to the scales in the literature reviewed above.

Q1: A lot of discount is supplied on group buying websites (Voss et al. 1998).
Q2: People often buy things above the price in value on group buying websites.
Q3: Buyers can be benefited from group buying which is a means of promotion.
Q4: I will decide to do group buying if a lot of people are doing group buying (Tseng and Chen 2011).
Q5: I believe I'll not be cheated if a lot of people are doing group buying (Lee 2009).
Q6: I believe the prices are low if a lot of people are doing group buying (Lee and Park 2008).
Q7: I'll join the buying group if they need me.
Q8: Fraud on group buying websites is rare.
Q9: Group buying websites attach importance to their reputations.
Q10: Group buying websites take complaints seriously.
Q11: I will do group buying if possible.
Q12: I'm going to take group buying as a way of purchase.
Q13: I will try group buying if this way of purchase is provided (Taylor and Todd 1997).

129.3.2 Data Collection

The data employed in this study were collected via a survey website called *Questionnaire Star* on which a questionnaire was posted first. And through the questionnaire invitation provided by the survey platform, the questionnaire links were sent to the known e-mails which belonged to the researcher's friends, colleagues, and the teachers and managers who were pursuing studies or doing research in the same college which the researcher of this study is working for.

129.3.3 Samples Constitutents

Totally, 420 invitation e-mails were sent, and 232 valid replies were collected. And the invalid replies were from those respondents who hadn't done online shopping, or the incomplete replies. Table 129.1 is *Sex and Age of Respondents* which shows the number and the percentage of the people grouped in terms of

Table 129.1 Sex and age of respondents

Age	Male	Female	Total
26–35	45(19.4 %)	62(26.7 %)	107(46.1 %)
36–45	28(12.1 %)	31(13.4 %)	59(25.4 %)
Over 46	1(0.4 %)	6(2.6 %)	7(3.0 %)
Total	93(40.1 %)	139(59.9 %)	232(100.0 %)

gender and age. From the distribution of the ages, the proportion of the sample group concords with that of the netizens.

Among the listed major Group-Buy websites which the respondents employed to purchase, *Lashou* was the most frequently dused. 171 respondents did online shopping via *Lashou,* which accounted for 73.7 % of the respondents. If all the listed websites are taken as an entire market, *Lashou* occupies 17.3 % of the whole market. Further calculation shows that each one surveyed used 4.26 websites on average.

129.4 Reliability and Validity

129.4.1 Reliability Analysis

To ensure reliability in qualitative research, examination of trustworthiness is crucial. Cronbach's alpha is an index of reliability associated with the variation accounted for by the true score of the "underlying construct." Construct is the hypothetical variable that is being measured. Alpha coefficient ranges in value from 0 to 1 can be used to describe the reliability of factors extracted. The higher the score, the more reliable the generated scale is. Nunnally (1978) has indicated 0.7 to be an acceptable reliability coefficient but lower thresholds are sometimes used in the previous studies. The statistics by means of SPSS show that Cronbach's Alpha is 0.858, which indicates the questionnaire has a high level of reliability.

129.4.2 Discriminant Validity

Discriminant validity tests whether concepts or measurements that are supposed to be unrelated are, in fact, unrelated. Campbell and Fiske (1959) introduced the concept of discriminant validity within their discussion on evaluating test validity. They stressed the importance of using both discriminant and convergent validation techniques when assessing new tests. A successful evaluation of discriminant validity shows that a test of a concept is not highly correlated with other tests designed to measure the theoretically different concepts.

Table 129.2 Rotated component matrix

Construct	Items	Factor 1	Factor 2	Factor 3	Factor 4
Externality	Q4 → Ex1	0.80			
	Q5 → Ex2	0.74			
	Q6 → Ex3	0.74			
	Q7 → Ex4	0.71		0.32	
Willingness	Q13 → Bu1		0.87		
	Q12 → Bu2		0.83		
	Q11 → Bu3		0.74		0.38
Trust	Q10 → Tr1			0.81	
	Q9 → Tr2			0.80	
	Q8 → Tr3			0.78	
Discounts	Q1 → Pr1				0.79
	Q3 → Pr2				0.77
	Q2 → Pr3		0.40		0.71

Component (Factor) analysis is to test whether cross-factor phenomena take place in the measurements of each construct, through exploratory factor analysis, namely, not only each measurement item should significantly reflect a single component, and hopefully the factor loading value is over 0.6, but also, for the other components, the factor loading value of each measurement item should be under 0.3. Table 129.2 shows the rotated component matrix. It is set to extract four components in the component (factor) analysis. The factor loading values shown are only those over 0.3. Table 129.2 indicates the first component consists of the measurement items of the network externalities, and the second, third and fourth components consist of the measurement items of the willingness to purchase, the perception of trust in the Group-Buy websites, and the cognition of discounts. The values suggest the good structure of the scale. Q7, Q11 and Q2 respectively have a high factor loading value in one component, but have a high value in another component, that is over 0.3, which demonstrates that the discriminant validity of these questions are a little poor.

129.4.3 Convergent Validity

Convergent validity is the degree to which an operation is similar to other operations that it theoretically should also be similar to. Composite reliability, c.r, as a common research approach in PLS, and another approach average variance extracted, AVE, are utilized in this study to test the internal consistency of the construct measurements. Chin (1991) and Fornell suggested that the value of CR should be over 0.7, while that of AVE should be under 0.5. An AMOS is set up based on the four constructs. Thus the measurement model of the four constructs is set up. In the model, CMIN, CMIN/DF suggests the model fits well.

Table 129.3 Standardized loadings and reliabilities

Constructs	Items	c.r	Ave	Loading
Externality	4	0.79	0.49	0.69, 0.71, 0.79,0.60
Willingness to buy	3	0.84	0.64	0.78, 0.86, 0.76
Trust	3	0.79	0.56	0.74, 0.76, 0.75
Discounts	3	0.80	0.58	0.62, 0.88, 0.75

Table 129.3 indicates that the reliability coefficients are all over 0.7, and the AVE demand externality constructs is near 0.5, which suggests a good convergent validity of the research constructs.

129.5 Findings and Conclusion

129.5.1 Testing the Model

Based the conceptual model, the two path analysis structural equation models are established. The standardized estimates are shown in Figs. 129.2 and 129.3.

Both models comprise the path of the network externality effects on the willingness to purchase. Model 1 takes discounts as an intermediary variable, and Model 2 takes the trust in Group-Buy websites as an intermediary variable. Table 129.4 is about Model Fit.

129.5.2 Direct Effect

Table 129.5 presents parts of the statistics of AMOS. The estimates of regression weights are non-standardized regression coefficients, and S.E. stands for the standard errors of the estimates.

C.R. is the value of the regression coefficient divided by the corresponding standard error of the estimate. The calculation shows that the absolute value of C.R. is over 1.96, which indicates that the estimates are significant. If the significant probability value P is under 0.001, the symbol "***" will appear, instead, if the value P is over 0.001, the value of P will appear. Table 129.5 shows the estimates of the two models respectively. Thus, the test results can be obtained directly according to the probability value. The research findings support the following hypotheses, H1, H2, H3 and H6, but not H4, as the two models obviously don't support it. Namely, the findings suggest that demand externalities have directly positive impact on the online buyers' cognition of discounts and their perception of trust in the Group-Buy websites. Besides, the online buyers' cognition of discounts and their perception of trust in the Group-Buy websites have

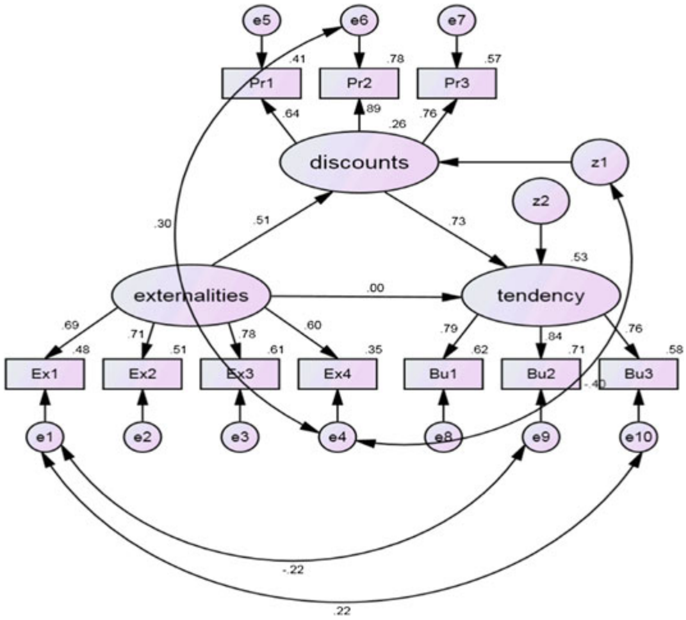

Fig. 129.2 Standardized estimates of model 1

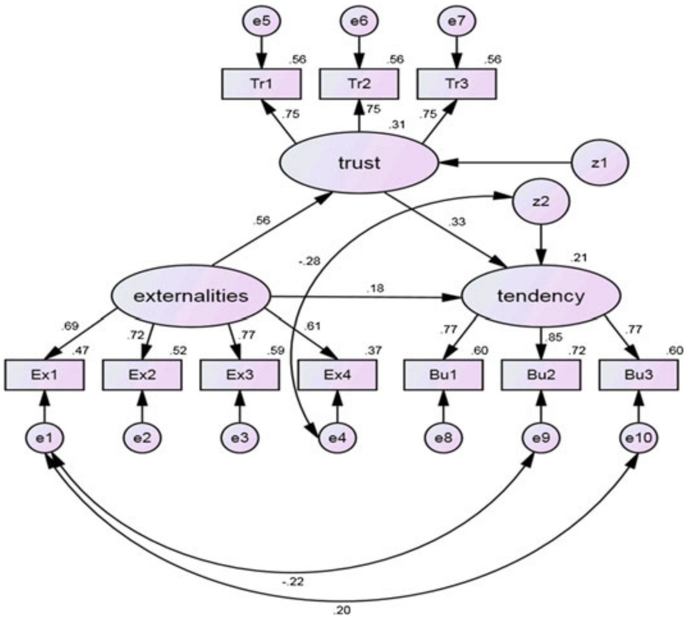

Fig. 129.3 Standardized estimates of model 2

Table 129.4 Model fit

	χ^2	*df*	*P*	χ^2/df	RMSEA	N FI	CFI
Fit indices			>0.05	<2	<0.05	>0.90	>0.90
Model 1	29.45	28	0.39	1.05	0.02	0.97	0.99
Model 2	26.87	29	0.58	0.93	0.00	0.97	1.00

Table 129.5 Regression weights of model

	Relationship	Estimate	S.E.	C.R.	P	H
1	Discount ← externality	0.49	0.10	4.80	***	H3
	Willingness ← externality	0.00	0.09	0.01	0.994	H4
	Willingness ← discounts	0.86	0.12	7.15	***	H1
2	Trust ← externality	0.65	0.11	5.79	***	H6
	Willingness ← externality	0.20	0.12	1.72	0.09	H4
	Willingness ← trust	0.33	0.10	3.32	***	H2

positive effects on the willingness to participate in online group buying. The direct impact of network externalities on the willingness to participate in online group buying is not significant.

129.5.3 Mediating Effects

When a variable can explain the relationship between a self-dependent variable and an independent variable, it is believed that the variable plays its medium role. The purpose of researching into medium is to explore the internal mechanism of the known relationships. Mediating variables, in theory, have great significance in two aspects: (1) mediating variables can integrate the existing theories; (2) the mediating variables can explain the deep-seated mechanism behind their relations. This study uses Bootstrap of AMOS to test the direct effect and the indirect effect. Statistics show the value P and the confidence interval as well. Table 129.6 presents the summary statistics of the two models.

Table 129.6 suggests that, in the two models, the cognition of network externality of Group-Buy has no direct effect on the willingness to participate in online group buying. And this result is consistent with the previous one in the same study. In Model 1, the cognition of network externality has a significantly indirect effect on the willingness to participate in online group buying through the cognition of discounts. In Model 2, the cognition of network externality has a significantly indirect effect on the willingness to participate in online group buying through the perception of trust in Group-Buy. In addition, the two indirect effects of the cognition of network externality on the participant willingness are 0.376 and 0.186, in the two Models respectively, which suggests a greater medium function of the cognition of discounts.

Table 129.6 Effects of “externality” on “tendency”

Model	Type	s	s.g	Hypothesis
1	Direct	0.001	0.939	H5
	Indirect	0.375	**0.001**	
	Total	0.376	0.002	
2	Direct	0.181	0.122	H7
	Indirect	0.186	**0.003**	
	Total	0.367	0.002	

The empirical results demonstrate the significant effect of network externality on the consumer’s willingness to participate in online group buying, which on the one hand, provides some reliable underlying causes for the main features of Group-Buy websites, on the other hand, forcefully explains why those websites can expand so rapidly and successfully. The network externality most forcefully explains the success of the typical Group-Buy websites.

129.5.4 Marketing of Group-Buy Websites

Group-Buy websites need to continuously collect and analyze the consumers’ information, learn about their psychological, cultural and social properties, and know about their shopping patterns, so as to make sure what factors will affect their purchase decision. Since network externalities are the important factors that influence consumers’ willingness to purchase, it is essential for Group-Buy websites to strengthen and highlight network externalities whose features involve the display of the number of the submitted order, setting the minimum orders in effect, setting the termination time, and setting the discount rate. Superficially, the mentioned features are not favorable to online transactions, or they are even unnecessary, for instance, some websites do not set the minimum orders in effect. However, such a feature can highlight the network externality effects, thereby enhance the consumer’s willingness to participate in online group buying. Furthermore, it is a significant way for Group-Buy websites to establish network community in a bid to attract consumers. From the academic view and in practice, network community makes an effective means to increase consumer viscosity. In reality, if the network externalities can be reinforced by the online community, a striking promotional effect will emerge.

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Chapter 130
Data Mining Techniques Applied in the Financial Industry

Liang Huo, Tao Wang and Liu Yang

Abstrat Data mining is the use of various techniques to discover knowledge from massive data, it has wide application and prospect. The article detailed introduction summarizes the concept of data mining, methods, and applications. And analysis, summarizes the application of data mining in the financial field, including trend forecasting, customer relationship management, financial crime detection, risk identification and risk management.

Keywords Data mining · Financial data · Prediction · Risk identification

130.1 Introduction

Bank, securities company, insurance company daily business will generate large quantities of data, using the database system can efficiently realize the data input, query, statistics and other functions, but can't find data in the presence of the relations and rules (Wang and Cao 2002), not according to the existing data to predict the future trend of development.

How can I not be overwhelmed by information from a vast expanse of water, discover useful knowledge, improve utilization of information? Therefore, we must find a effective method, automatic data analysis and processing, we quickly find valuable information. Then, the data mining technology will emerge as the times require, and is able to develop flourishingly, more and more show its

L. Huo · T. Wang
Department of Information Management and Engineering, Hebei Finance University, Baoding, Hebei, China

T. Wang (✉) · L. Yang
Experimental Center of Economics and Management, Hebei University, Baoding, Hebei, China
e-mail: Wangtao731018@126.com

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powerful vitality (Wang 2009). It can be a lot of data from the extraction of potentially useful information and models, to help us to make scientific decision.

At the same time, the operation of financial institutions must be financial risk. The risk management is one of the important work of financial institutions. Using data mining techniques can not only from this data was found hidden in the subsequent rule, and can well reduce financial risks (Yang 2002). Study and application of data mining technology of China's financial institutions have an important significance.

130.2 Methodology

130.2.1 Basic Concept

1. Data Mining. Data mining is from a large, incomplete, noisy, fuzzy and stochastic data, in which the extraction of implicit, unknown, but potentially useful information and knowledge process. Discovery of knowledge can be used for information management, query optimization, decision support, process control and so on, can also be used for data maintenance (Yang 2002).
2. Data Warehouse. Data warehouse is wrote by W. H. Inmon in his book "Building the Data Warehouse" presented in the 1993. W. H. Inmon to the data warehouse is definition as: "a data warehouse is a Subject-Oriented, Integrated, Nonvolatile, Time-Variant data set, in order to support management decision-making process (Amihud and Mendelson 2005)." The data warehouse can be in a data model, under the guidance of the collection system, internal and external data, to ensure data consistency, accuracy and timeliness, realize data sharing and analysis using.

130.2.2 Main Technical of Data Mining

In application to a variety of financial areas in data mining technology, basically have the following kinds of methods.

1. Based on neural network method.

The neural network method is to simulate the human information processing process of a kind of intelligent information technology. Artificial neural network is the computer through a multiple input similar parallel processing structure to simulate human pattern recognition function to build up (Boyd and Hu 2005).

Neural network consists of a series of basic processing unit (also known as neurons), the processing unit according to the layer distribution. Most neural network consists of three types: the input, hidden and output layers. The mining process is basically the data clustering and classification, calculation of weight (Brank et al. 2005). Neural network is used to store the captured knowledge and for future use, it is used to describe the association between neuron models, capture in a given collection of data between independent variable and dependent variable causal relationship.

Neural network is suitable for non-linear data and noise data, so the database analysis and modeling is widely used. Neural network provides a satisfactory accuracy, close the modes of financial tools.

2. Based on the Bayesian networks method.

Bayesian networks (Bayesian network), also called the probabilistic causal network, a web of trust, knowledge map, is a directed acyclic graph. Bayesian network graph to represent the variables connected probability. Nodes represent: field variables; directed edges between nodes: dependencies; for each node corresponds to a conditional probability distribution table, the table indicates the distribution of the variables and dependencies between the parent node (Zurell 2002).

3. Genetic algorithm.

The basic principle of genetic algorithm is given a question, in a unique population genetic groups potentially containing a solution or a better solution. Based on genetic and evolutionary principles, genetic algorithm repeatedly revised population artificial structures, an operator through a preset, select, crossover and change to gradually form a solution.

4. Based on the rules and decision tree tools.

Most data mining tools use rule discovery and decision tree classification techniques to find data patterns and rules its core is an inductive algorithm. Tools of this kind are usually on the database data mining production rule and decision tree, and then to new data analysis and prediction. Tools of this kind are the main advantages of rules and decision tree are readable (Han 2005).

The classification tree method as a kind of data mining based on statistic theory non parameter identification technique, not only to maintain multiple parameters, nonparametric statistics, some of the advantages, but also overcomes the shortcomings, mainly displays in: automatic variable selection of reducing dimensions, make full use of prior information processing data between the non homogeneous, and can effectively for the classification of the data.

5. Based on the fuzzy logic tool.

The method is the application of fuzzy logic for data query, sort. The tool uses fuzzy concept and “recently” search techniques of data query tool, which allows users to specify the target, then the database search, find out close to the goal of all records, and evaluate results.

6. Rough set method.

Rough set method is proposed by Z. Pawlak in 1982 Poland mathematician. It is used, lower approximation set to deal with uncertain problem. It does not require prior knowledge of data obtained, using only the data itself provides information, fully contained in the data mining. The specific application of the rough set method is usually used in conjunction with other methods, such as the use of rough sets to obtain the initial rule set and then construct the corresponding neural network model (Han et al. 2004).

130.2.3 The Main Steps of Data Mining

1. Problem definition. The goal of a clear, clear definition, is also identified the need to solve the problem, the goal should be feasible, capable of operating and evaluation.
2. Data collection. A full rich data mining is premise, no data, data mining will not be. Therefore, data collection is the first step in data mining. Data can be derived from the existing transaction processing system, can also be obtained from the data warehouse (Basel Committee 2000).
3. Data processing. Data collection is the necessary link of data mining. By the data collection phase of data may have a "pollution", manifested in the data may have its own inconsistency, or the existence of missing data, so data collection is a must. At the same time, through the data collection, data can be a simple generalization process, thus the data in the original basis to obtain more abundant data information, and then for the next step of data mining is carried out smoothly (Han and Kamber 2001, 2006).
4. Data mining. The use of artificial intelligence, mathematical statistics and other data mining methods to analyze the data, to discover useful knowledge and mode. The core of the whole process steps.
5. Data mining result assessment. Data mining of some of the results are meaningful, but some are not practical, or with actual condition is violated, it will need to be evaluated. Assessment can be based on user experience, but also can be directly used actual data to verify the correctness of the model, and then adjusting the mining model, repeated data mining (Berson et al. 2000).
6. Analysis and decision. Data mining is the ultimate goal of aided decision. Decision makers can according to the result of data mining, combined with the actual situation, adjust the competitive strategy.

In conclusion, the data mining process requires a lot of problems, adjustment, a reassessment of modified model, test cycle is repeated, will it be possible to achieve the desired effect.

130.2.4 The Data Mining Application in Financial Industry

Data mining in the financial field, including: financial market analysis and prediction, classification of accounts, bank guarantee and credit evaluation. These financial business needs to collect and process large amounts of data, it is difficult to manually or using the one or two small software for analysis and prediction. Data mining can be based on the existing data, find the data characteristics of the object and the relations between objects, and can be observed in the financial market trends. And then learning to use the model of rational analysis and prediction, and then find a customer, consumption group or organizational financial and commercial interests.

1. In customer relationship management. Data mining can be customer behavior analysis to discover customer behavior. Including the overall behavior and group behavior mode, market department can reason these rules to formulate appropriate marketing strategies and tactics; also can use this information to identify the customer concerns and consumption trend. In order to improve the market share of products and the competitive ability of the enterprise. Data mining can help the enterprise to find out that has important sense to the enterprise customers, including enterprises can bring huge profits to the gold customers and enterprise to further development of the potential customer (Zhang et al. 2005).
2. Risk identification and risk management. To build a classification model, bank loans to the safety or risk classification also the use of data mining technology in the control of credit risk. Credit risk management include: risk identification, risk measurement, risk management tool, effect evaluation. All process involves information includes the relevant commodity market situation, industry, industry development, enterprise management, personnel, financial condition and a series of content, information caused by manual evaluation, complex management difficulty to increase greatly. While the existing bank credit system is generally a business operation system, not for the decision analysis and the establishment of its application, data integration, integrity, accessibility, analysis are difficult to meet the demand of credit risk analysis. For this reason, it can establish a set of independent business system data warehouse, specifically addressing the credit analysis and risk and management issues (Xiong et al. 2004).

We can use a Bayesian network to establish the bank operational risk management system framework. Bayesian networks can be used to help identify risk factors, calculation of sensitivity and volatility, simplify the loss distribution based on scene and excess of loss event generation. The operational risk based on Bayesian network model first need to establish business model, then according to the business model of Bayesian network structure, using historical data or analog data to train the model, get the conditional probability distribution, using the model of production loss distribution or operational risk metric.

3. Market trend prediction. Data mining technology can forecast the trend of data, such as financial market price trend forecast, customer demand changing trends.

Identification of 4 financial fraud, money laundering crime of economy. Financial crime is one of the toughest issues, including malicious overdraft, Pirates of the card, credit card fraud, theft of the account password and money laundering, a serious threat to people's property and the normal functioning of the financial system. To detect money laundering and other financial crimes, it is important to multiple database information integration, and then using a variety of data mining tool to find the abnormal pattern. Found within a short time, a small number of staff between the huge cash flow, the suspicious trail (Kim 2003).

130.3 Conclusion

Data mining in the financial field has wide application, at present in China's financial industry has just started, need to be further research, development, promotion. We should focus on the study of data mining technology in the market, price trend, fraud detection, transaction pattern recognition, customer relationship management and other applications. With data mining software maturity and financial industry to accelerate the pace of information technology, the data mining technology in the financial field in our country will be able to play its great power, in order to improve the banking, securities and other enterprise management level and the competition strength contribution.

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Chapter 131
Evaluation of Hospital Competitiveness in Jiangxi Province Based on the Cluster Analysis

LiQing Li and Lei Xia

Abstract With the system researching in the concrete hospitals and consulting to relevant experts, the paper took fourteen third-grade-A-class comprehensive hospitals in Jiangxi province as an example, established comprehensive evaluation index of hospital competitiveness, and spent more than five months to collect and organize the data of evaluation index. Through the statistical software spss16.0, classified the fourteen hospitals into three groups, four groups and five groups based on the hierarchical cluster analysis, and explained the classification results in detail. From a practical point of view, it proved that the classification results keep consistency with the actual situation of hospital in Jiangxi province.

Keywords Hospital competitiveness · Evaluation · Cluster analysis

131.1 Introduction

The third-grade-A-class comprehensive hospitals as an important part of our public hospital, has played an important role to protect people's health. Objective, accurate and scientific evaluation of the comprehensive hospital competitiveness always not only provides management countermeasures to improve competitive advantage, but also provides a new strategic direction and diversification of new thinking for hospital development.

L. Li (✉) · L. Xia
Department of Economics and Management, Jiangxi Science and Technology Normal University, Nanchang, China
e-mail: liliqing_lily@163.com

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131.2 To Select Evaluation Index of Hospital Competitiveness

Scientific, objective evaluation of competitiveness of hospitals is significant to enhance the management levels of hospitals. It is the key of evaluating competitiveness to build an adaptive index system, which is need to keep the consistent with the actual situation of hospitals and be established accurately, objectively and systematically, and at the same time, the collection and assignment of samples is crucial for data processing and analysis.

The paper collects much useful data through literature review and the investigation to the concrete comprehensive hospitals in Jiangxi province, based on the characteristics of hospital competitiveness and the actual situation of comprehensive hospitals in Jiangxi province, the paper set up an evaluation index system through the quantitative and quantitative research methods and framework of analysis of the competitiveness theory in management, but also with the help of domestic and foreign research results of comprehensive competitive of relevant hospitals. Finally, the evaluation index system is established to be consistent with competitiveness evaluation index system of comprehensive hospitals in Jiangxi province from three aspects: hospital resource capacity, the hospital clinical and hospital management capacity, as is shown in Table 131.1

Table 131.1 Evaluation index system of hospital competitiveness

I	II	III
Hospital competitiveness	Resource capacity	Ration of health technicians to open beds
		Ration of health technicians to hospital staff
		Ration of senior technical staff to health technicians
		Ration of post-graduate number to hospital staff
		Hospital beds
		Number of clinic department
	Clinical capacity	Annual outpatient number (unit: million)
		Annual operations performed number (unit: million)
		Annual hospitalization number (unit: million)
		Bed utilization;
		Bed turnover
		Average day of hospitalization
		Diagnosis rate of 3 days
		The identical diagnosis rate of admission to discharge
		Ration of severe or difficult cases to total cases
	Managerial capacity	Per capita revenue
		Scientific research achievement
		The number of key disciplines

Data collection is very important to statistical analysis, the paper uses the surveying methods, superior departments consulting method and expert scoring method when collecting the date. After nearly five months of research, data collection and collation, all kinds of index value of 14 third-grade-A-class comprehensive hospitals in Jiangxi province were defined for evaluating competitiveness. As the reason of showing respect to the hospitals and protecting of the data, we didn't publish their names in this article and just used h1–h14 to stand for them without any order, only arranged randomly.

131.3 The Introduction of Hierarchical Clustering Analysis Methods

Cluster analysis is a multivariate statistical analysis method for establishing classification, it can classify a set of samples or variable data automatically according to their features, the degree of closeness based on the nature without any prior knowledge, bringing out multiple classification results.

Hierarchical clustering, also known as systemic clustering, it includes Q-cluster and R-cluster. Because the data in the paper is fixed pitch variable, for this it commonly uses Euclidean distance method or squared Euclidean distance method to calculate the distance between individual variable, the mathematical definition are as follows:

$$D(x,y) = \sqrt{\sum_{i=1}^{k} (x_i - y_i)^2},$$

$$D(x,y) = \sum_{i=1}^{k} (x_i - y_i)^2,$$

The xi is the value the i-th variable of x, the yi is the value the i-th variable of y.

131.4 Empirical Analysis

The paper used the shortest distance method and the longest distance method to clustering systematically.

The shortest distance method is defined as the distance between two classes is the distance between the two nearest sample, that is:

$$D_{ij} = \min_{x_i \in G_i, x_j \in G_j} d_{ij}$$

Table 131.2 Agglomeration schedule of hierarchical cluster

Stage	Cluster combined		Coefficients	Stage cluster first appears		Next stage
	Cluster 1	Cluster 2		Cluster 1	Cluster 2	
1	9	11	4.981	0	0	2
2	9	12	6.642	1	0	4
3	10	14	6.846	0	0	4
4	9	10	9.144	2	3	5
5	9	13	12.756	4	0	7
6	3	6	17.238	0	0	10
7	8	9	17.375	0	5	10
8	4	7	17.561	0	0	11
9	2	5	20.526	0	0	12
10	3	8	26.060	6	7	11
11	3	4	29.985	10	8	12
12	2	3	41.523	9	11	13
13	1	2	88.815	0	12	0

The longest distance method is defined as the distance between two classes is the distance between two farthest sample, that is:

$$D_{ij} = \max_{x_i \in G_i, x_j \in G_j} d_{ij}$$

Because the index values are different in order of magnitude, the paper should eliminate the difference by Z fraction approach. With statistical software spss16.0, through running the hierarchical clustering function, can get the condensed state table in the hierarchical clustering analysis, as shown in Table 131.2. Through the shortest distance method and the longest distance method respectively, can obtained the same analytical results, as shown in Table 131.3.

Table 131.3 Cluster membership

Case	5 Clusters	4 Clusters	3 Clusters
1:h1	1	1	1
2:h2	2	2	2
3:h3	3	3	3
4:h4	4	4	3
5:h5	2	2	2
6:h6	3	3	3
7:h7	4	4	3
8:h8	5	3	3
9:h9	5	3	3
10:h10	5	3	3
11:h11	5	3	3
12:h12	5	3	3
13:h13	5	3	3
14:h14	5	3	3

In Table 131.2, the first column represents the step of the cluster analysis, The second, and the third column represent which two samples or subclasses clustered into one class. The fourth column is the individual distance or subclasses distance; the fifth and the sixth column indicate whether individuals involved in the clustering or subclasses. Zero indicates sample, non-zero means subclasses generated by the nth step cluster involved in this cluster; the seventh column means in the following steps this results will be used

It can be seen from the tree diagram of cluster analysis that if the 14 third-grade-A-class comprehensive hospitals of Jiangxi province were classified into five categories, the first one is h1, the second are h2 and h5, the third are h4 and h7, the forth are h3 and h6, the fifth kind are h8, h9, h10, h11, h12, h13, h14. This classification result is in accordance with the actual situation in Jiangxi province. Although they are all three level comprehensive hospitals, the scale facilities, management, medical environment and etc. are obviously different due to the different of development background and history.

h1 is located in the bustling section of the capital city of Jiangxi province, it has advantages in geographical environment, convenient transportation, advanced software and hardware facilities. At meantime, the patient source is stable, the medical resources are rich, the professional capacity and scientific research ability is strong, public image is nice, which is the most competitive hospitals. h2 and h5 are also located in the center of the capital city of Jiangxi province, they also have convenient transportation, advanced hardware and software facilities, good fame and public image, but the professional ability and research ability is weaker than h1, h4, h7, and h3, h6 are in the center of Nanchang, they also have advanced software and hardware facilities, but the hospital scale, medical resources, professional capacity and management are worse than class 1 and class 2, Their competitiveness need further enhance. h8, h9, h10, h11, h12, h13, h14 are mostly belong to the municipal hospital, the geographical environment, hardware and software facilities, professional capacity, scientific research level, patient source are worse than the provincial capital hospital, At the same time, several hospitals are just rating the three level comprehensive hospitals, despite each index reach the standard, but if compared with class 1, class 2, there is still a long way to improve. If we classify the 14 third-grade-A-class comprehensive hospitals, of Jiangxi province into four classes, the first class is h1,the second are h2 and h5, the third are h4 and h7, and the forth are h3, h6, h8, the h9, h10, h11, h12, h13, h14; If we classify them into three categories, the first class is h1, the second are h2 and h5, the third are h3, h4, h6 and, h7, h8, the h9, h10, h11, h12, h13, h14.

131.5 Conclusion

Firstly, the paper establishes evaluation index system of third-grade-A-class comprehensive hospital competitiveness based on systematic research, expert interviews, literature review and considering the actual situation of Jiangxi province.

Secondly, classified the 14 three level comprehensive hospitals and gave out the related explanation through the hierarchical clustering analysis method based on statistical software spss16.0. The result is in accordance with the actual development situation of the hospitals in Jiangxi province, which has great significance to improve the hospital competitiveness.

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Chapter 132
Study on BPR of Small to Medium Enterprise Based on E-Commerce

Rong-fu Zhou

Abstract The purpose of this paper is to study the concrete way for small to medium enterprises (SMEs) to reengineer its business process in the E-commerce environment. Following the organization structure design principle, the concrete countermeasures of reengineering business process are proposed from the following aspects. From the aspect of organization structure, re-integrate the existing department, outstanding information department function; from the aspect of decision making mechanism, empower to workers sufficiently; from the aspect of organization run, establish the trust mechanism, information share mechanism, principal-agent mechanism and benefit share mechanism. Finally, the validity of proposed reengineering project has been verified through an actual example.

Keywords E-commerce · Mechanism · Process reengineering · SMEs

132.1 Introduction

With the electronic commerce widespread applied in enterprise management, there has been a new tendency to use the electronic commerce reform enterprise management. The electronic commerce application is not merely simply graft the enterprise service on the Internet. Enterprise should guarantee the operation process is correct before introducing information technology. This is the real reason why it requests the enterprise to carry through BPR before the use of electronic commerce.

Since Hammer and Champy (1993) proposed the concept of BPR many scholars have made a large number of studies (Kim and Kim 2001; Gregory and

R. Zhou (✉)
College of Management, Yanshan University, Qinhuangdao, China
e-mail: zhrf@ysu.edu.cn

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McFadden 2007; Chen and Lee 2007). To SMEs business process reengineering. Liaijun (2010) studied supply chain process reengineering of a small enterprise but not general. Wu and Wang (2007; 2008) analyzed possible problems in reengineering SMEs business process. Peng (2005) analyzed the necessity and critical success factors of SME business process reengineering. Tatsiopoulos (2002) proposed a structured methodology for the evaluation of alternative Electronic Commerce technologies to be introduced into SMEs' every-day business practices. Liu (2004) proposed BPR method From organizational structure. Sun (2007) proposed use Entity-activity relationships to reengineering the SMEs.

Above study results only apply the basic principles of the BPR in SMEs, emphasis on the theoretical level, lack of specific reengineering methods. This paper will present the specific business process reengineering methods to SMEs in the e-commerce environment.

132.2 Strategic Construction for to Realize BPR Under E-Commerce Environment

132.2.1 Reestablish the Interior Function Department

Under the electronic commerce environment, some traditional departments should be cut off and some traditional departments will transfer its center on net and some new departments will appear in the enterprise. For example, for the existence of Internet, information center will become the important department because of the high importance of discriminate and dispose information. We should establish a special department to build and manage enterprise's website because the connection with outsides, company visualize and service quality become more and more important. As for the traditional production department, it will focus on customers and achieve AM, Customization Manufacturing, and stride space–time manufacturing with the aids of Internet and Intranet. The collaboration between departments in production system and between production system and sale system will make production and sale more effective and more abstemious and realize management modernization.

132.2.2 Moving Down Decision-Making Point

Under the electronic commerce environment, enterprise's organization mechanism response to the market demand must be quick, exact and good. SMEs in China have the point of centralization of company power and the business status relies on proprietor's quality and experience. In this kind of situation, the executor, inspector and decision-maker in most of enterprises are separated strictly. To locate the

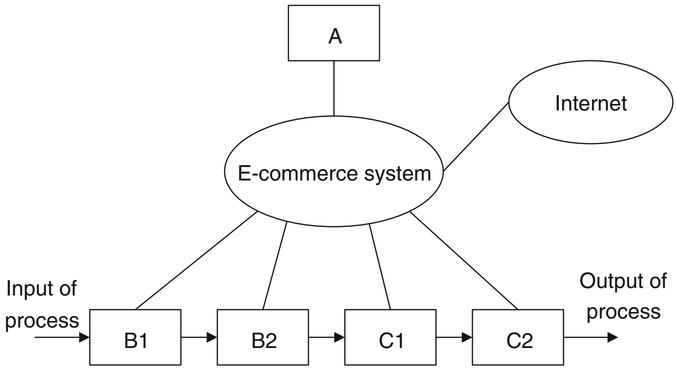

Fig. 132.1 More effective organization process chart under the E-commerce environment

decision-making point at the executing place through control program in the business process is the key and difficult point. Bring information processing into these information practical works is the most important job. That's to say let the bed staff complete the information processing work themselves and let them self-control and self- decision and optimize the entire process to the mechanism that don't need to rely on proprietor. After reengineering, new organization structure is shown as Fig. 132.1.

132.2.3 Rebuilding Organization Operation Mechanism

With the intense competition, the enterprise will remain invincible in market only by establishing stable supply-chain alliance. To SMEs, it is a worth researching problem that how to enable them be a stable node in the supply chain which means to be accepted by a supply chain alliance and cooperate with upstream firms and downstream firms. To solve this problem, the SMEs should rebuild the organization operation mechanism as the following:

1. *Establishing trust mechanism:* The supply chain cooperation relationship is formed in the environment of integrative supply chain union and forms between ones with specifically aims behalf. The cooperator in a supply chain would not foresee the future fully and subscribe contract in the market environment. In building supply chain strategy alliance, the cooperation based on trust is the essential idea and the trust mechanism is the basic of realizing the supply chain conformity and cooperative operation. In the famous "Prisoner's Dilemma", the two prisoners can only get rewards simultaneously under the condition of trust. In the process of supply chain conformity management, trust is one kind of strategic resources; it can effectively promote the division and cooperation,

reduce the transaction cost and strengthen respective core competitive advantage.

The trust mechanism establishment, the trust relationship continues and development should be based on Common Vision. First, choosing the point to cut into and appealing along a common value master line. The company can establish common value chain and enterprise trust and cooperate relationship by do SCORE. In addition, the union member's honest cooperation, the opening communication and the together question solution are the basic prerequisites.

2. *Information sharing mechanism:* In order to make the supply chain synchronization, the frequency of information alternation among supply chain enterprises is much more than that of traditional ones. Therefore, we must change the point-to-point information communication way and change serial structure into parallel structure information communication process and establish network information feedback mechanism. By establishing unified information sharing network platform, omni-directional network information sharing can be realized which provides a highly effective information communication and harmonious cooperate operation environment for the main body of supply chain alliance. Thus, the pitch point enterprise may make accurate and quick decision about production and stock according to its downstream firms' ordering information and consumers demand forecasting information. This is good to the whole supply chain to realize JIT purchase, JIT production and JIT delivery.
3. *Principal-agent mechanism:* From one point in multi-echelon supply chain, information asymmetry exists between the supply side and demand side in supply chain. On the one hand, the upstream supplier may make wrong service commitment because of the lack of certain ability to provide some kinds of services. The downstream ones and some customers with poor information can't recognize supplier's ability and make Adverse Selection. On the other hand, for lacking the active oversight, the suppliers maybe not take the whole supply chain benefit maximization but its own benefit maximization as the standard and adopt deceitful behavior, namely existing Moral Hazard problem. Obviously, the relationship between supplier and customer shows the dissymmetry and the imperfection of contract. The relationship between the two sides has strict Principal-agent relationship in economics. This determines that building supply chain alliance is a behavior of "nonzero and cooperate games". SMEs can research the relationship between the node enterprises in supply chain based on Principal-agency theory and build the restraint mechanism urge all of them abide by their commitment. They can design supply chain contract and arrange system by some invigorative ways and castigatory restrict methods such as sharing the risk, giving prices discount, increasing the order batch flexibility, income sharing and benefit compensating, etc. The moral risk of hidden action and information by eliminate the client (generally is manufacturer and core enterprise), worried agent (generally is supplier or dealer) make the agent pursue own effectiveness maximization at the same time promote the

Principal's benefit maximum; that is to say, realize the benefit uniformity on both sides.

4. *Income sharing mechanism:* The partners' fair sharing of the exceed repayment should be realized by clearly marking the value and benefit gained by reducing the cost and the stock and using resources highly effectively.

132.3 The Case Analysis of SMEs BPR

132.3.1 The Situation of BS Company Before BPR

BS Company is a medium-size private company whose business is machine-finishing, which means it takes external cooperation task from other companies. It has machine-machining workshop, operation department, storehouse management department, finance department and purchasing department, etc. The production process type is small batch and multi-varieties, namely put up immediate production according to the order's technical requirement and generally does not have massive repeated production and little stock.

In early time, the company is small and business is simplex. Various departments' horizontal function and the differentiation degree of production process are not obvious. There aren't too many interdependent and uncertain questions and the staff mutual recognition degree is high, the illegibility is low and the degree of privities among the staff is high. It never has fault situation in product quality and delivery time after getting an order from a customer. Along with the business growth and expansion, the volume of company interior information processing and the degree of business complex are increasing. The interdependent uncertainty and illegibility between internal members begin to upgrade. The company establishes a list as the main mechanism among the various units. The business process is shown in Fig. 132.2.

The client need negotiate with transaction department, storage management department, finance department and transportation department and need to deal with various bills and documents, such as order intention, quotation, bargain, account payable, bill of lading and invoice, etc. The process is very trivial and lead time is long. It is very inconvenient for the client, which may result in client losing.

132.3.2 New Process Design

Facing this situation, the BS decision-maker decided to carry through BPR and redesign contract by information technology to fit for the new process in e-commerce environment. New process is shown in Fig. 132.3.

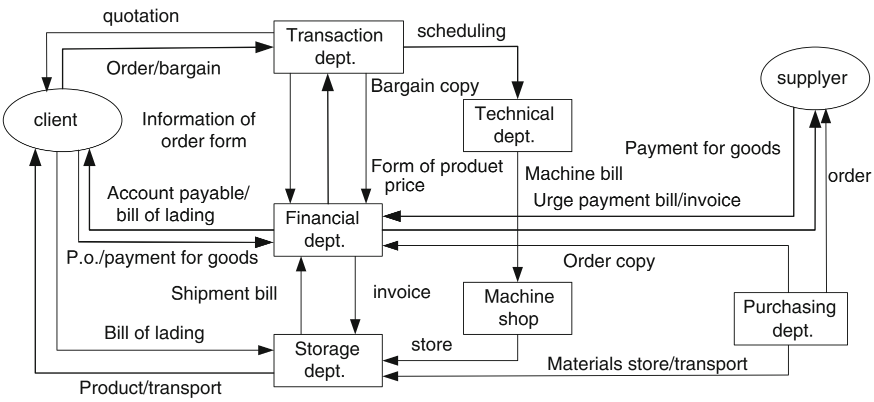

Fig. 132.2 The business process before BPR

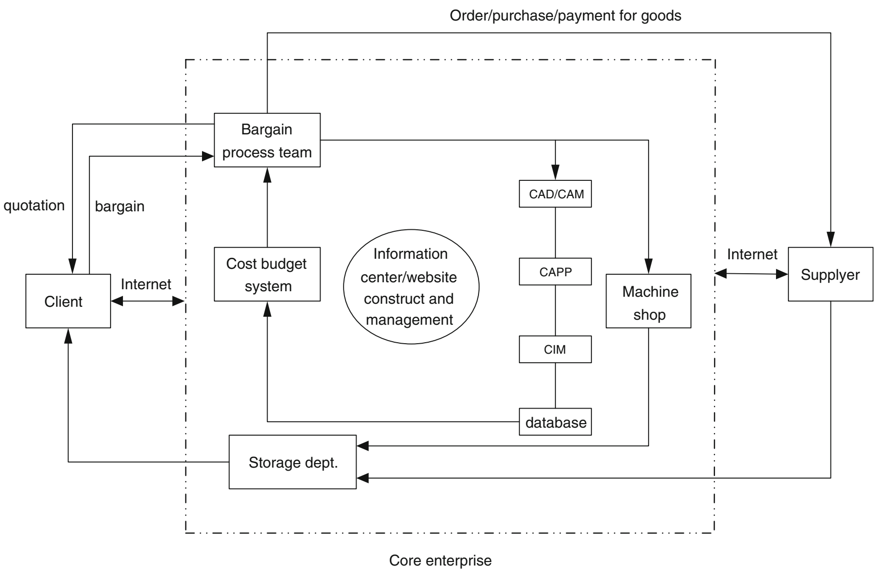

Fig. 132.3 The new process based on E-commerce

This new process has the following characteristics:

1. *More rapid response to the customer:* Merge different duties and works in the past. For instance, in the past, to sign a bargain must through the following steps: order intention → quotation → bargain. Because of the particularity of machine-machining department, transaction department can not quote immediately. It can only quote after finance department check the cost of the sample. This kind of bargain spends two days at least. Therefore, BS set up a special bargain process team that is responsible for bargain signing. The members

come from transaction department, finance department and technical department and orangeade form is adopted. It introduces advanced CAD/CAM, simulation system and cost estimate system to work in flow operation to save time and reduce management cost. This process reduces the lead time from two days to 30 min and improves working efficiency enormously.

2. *Down moving and dispersing the decision-making point:* The BPR simplifies the process not only on horizontal aspect but also in vertical aspect, that is to say, the team members have the responsibility to entire process, thus they have decision-making power to the process.
3. *Using parallel process to exceed organization boundary:* In the traditional process, we must start each step after the previous one is finished, but after BPR, we can dispose certain process paralleled. In e-commerce environment, the realized information sharing makes it possible for marketing people to start the production's technical design after they collect enough information, instead of starting it only after finishing all the market research. This makes many work processes at the same time and saves a lot of time that has been lose between two steps before.
4. *Using information technology to establish standard operational procedure and reduce the inspection and control:* BS has established MIS in the whole company scope and has realized information sharing among departments. The decision-maker can have all of departments' information simultaneously and make it possible to synthesize using the centralization and power- dispersing system. It has established the standardized procedure and stressed the standard request in business processes time and way by information technology. This standard operational procedure is the enterprise activities' important benchmark. The significance is not on providing reference to operation but is propitious to reasonable thinking in making flow. BS also corrects its standard operational procedure regularly to fit the market, with the unceasing mutative competition environment.

132.4 Conclusion

The e-commerce creates lots of opportunities for SMEs, at the same time, alters the way of business operation. The BPR is the only way to carry out e-commerce to SMEs. It can only be successfully used in SMEs under the condition that significant rebuilding and innovation are made in organizational structure, decision-making mode and supply chain management.

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Chapter 133
Research on Relationship Between Academic Achievement and Efficiency Consciousness of IE Students Based on SPSS

Jin-yuan Zhong, Kai-hu Hou, Xiao-li Zhu, Cai-xia Zhang and Li-hua Chen

Abstract In order to explore the relationship between academic achievement and efficiency consciousness of IE students, Efficiency Consciousness Scale (ECS) was designed by consult the ways to improve work efficiency. ECS was divided into 5 subscales. They are sense of imitation (SOIT), competition (SOCP), concentration (SOCC), happiness (SOHP), and habit (SOHB). Class 061 of IE in Nanchang University was the test subject. By collecting each conscious of every students and their academic achievement, Correlation analysis and regression analysis were conducted. The result shows that the academic achievement of IE students depend largely on efficiency consciousness (59.7 %).

Keywords Efficiency · Academic achievement · SPSS · Imitation · Completion · Concentration · Happiness · Behavior

133.1 Introductionxc

There are many differences between college students and high school students. For college students, entering college is not a cardinal task. Exam-oriented education is instated of professional education. Professional education has its own characteristics: courses become more and harder, the initiative of study is strongly needed. Academic achievement, being an important index to value students, has attracted many researchers' attention at home and abroad. The following are some

J. Zhong (✉) · K. Hou · L. Chen
Department of Industrial Engineering, Kunming University of Science and Technology, Kunming, China
e-mail: 405629566@qq.com

K. Hou
e-mail: Kaihu_kmustie@163.com

X. Zhu · C. Zhang
Department of Industrial Engineering, Nanchang University, Nanchang, China

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achievements of recent researches: Yuhong (2008) found that there is apparent positive correlation between achieve goal orientation, autonomous learning of college students and English achievement. Zhang et al. (2008) found that there are obviously relationship between learning adaptability of Medical college students and whose academic achievement. Long (2008) found that the general self-efficacy level is a predictor for medical undergraduates' academic achievement. Chen (2007) found that the differences in cognition have no effect on college students' academic achievement. Zhilong's et al. research (2006) divided the factors that influence the academic achievement into intelligent factor, academic motivation, personality, sentiments, self-conception, family, social factor. Zhang and Di (2009) found that there is a strong correlation between learning attitude and academic achievement. Li (2005) found that willing, attitude, and interest is the important factors that influence the academic achievement. The above researches announce the factors that influence the academic achievement in some psychological way. Yutinig (2011) found that academic achievement is highly sensitive to the factors that existed in the system. Zhuanmao et al. (2002) found that college students with good academic achievements are more self-disciplined and introversive, they are more sensitive and less healthy mentally, less capable to copy with defeats, while those with poor achievements are less self-disciplined with poor-confidence and also have poorer in mental health. Yin research (2010) holds the view that it is important to strength undergraduate's efficiency consciousness. Culia (2009) found that variables number of quizzes, gender, and course affiliation have an impact on the performance of students. Kolari et al. (2008) found that a deep approach to learning is desirable and is seen to support comprehension and lead to better learning outcomes. Sua (2007) found that the students' general attitudes and achievement orientations towards learning of science and mathematics in English do not indicate that the policy has achieved its objective. Halawah (2011) found that Motivating College students' learning is an essential goal for teachers and educators in higher education institutions. Morris et al. (2011) provided insights into the issue of implementing VISOLE and game-based learning in general in school education. There is litter research on the relationship between academic achievement and efficiency consciousness. This paper took efficiency consciousness into consideration, consulted the ways to improve work efficiency, designed the questionnaire of Study Consciousness Scale, and finally correlation analysis and regression analysis was conducted.

133.2 Methodology

133.2.1 Participants

The whole class061 of IE in Nanchang University is the test subject. There are 42 students, in which 36 male students and 6 female students. Their age ranges from 20 to 24.

Table 133.1 Internal consistency index of each subscale

Subscale	No of items	Cronbach's Alpha
Sense of imitation	5	0.730
Sense of competition	5	0.722
Sense of concentration	5	0.710
Sense of happiness	5	0.731
Sense of habit	5	0.753
Efficiency consciousness	25	0.734

133.2.2 Measures

Efficiency Consciousness Scale (ECS) developed by the author was adopted to assess efficiency consciousness of participants. The scale consisted of 5 subscales. They are sense of imitation (SOIT), sense of competition (SOCP), sense of concentration (SOCC), sense of happiness (SOHP), and sense of habit (SOHB).

The total score of them represents the efficiency consciousness. Each subscale is consisted of 5 questions which include 5 items with a 5-point scale ranging from totally disagree to totally agree. The ECS showed satisfactory internal consistency, good test–retest reliability, and construct validity. The internal consistency index (Cronbach's alpha) of each subscale is show in Table 133.1.

The questions include positive tone and negative tone. The answer must be exchanged to the score following the rule of Table 133.2.

There are differences among academic achievement of each semester. In order to increase the reliability of academic achievement, other unnecessary factors should be rejected. Sum the participants' academic achievements of each final exam from 2006 to 2009. The sum represents the participants' total academic achievement.

133.2.3 Data Entry and Analysis

Collect the questionnaire and conduct statistical analysis in SPSS16.0 after data entry.

133.3 Results

133.3.1 Data Preprocessing

Tests of Normality had been conducted. As the participants are less than 50. So the method of Shapiro–Wilk is used. The result is shown as Table 133.3.

Table 133.2 The rule of exchange the answer to score

Tone	Totally agree	Agree	Hard to say	Disagree	Totally disagree
Positive	5	4	3	2	1
Negative	1	2	3	4	5

Table 133.3 The result of test of normality

	Statistic	df	Sig.
SOAA	0.961	42	0.162
SOIM	0.958	42	0.130
SOCP	0.976	42	0.501
SOCC	0.941	42	0.030
SOHP	0.976	42	0.508
SOHB	0.966	42	0.245
EC	0.988	42	0.929

From Table 133.3, we can know that the significance of SOAA, SOIM, SOCP, SOHP, SOHB, EC are desirable to have a value of more than 0.05. It indicates that these data fit the normal distribution. However, the significance of SOCC is 0.03, less than 0.05. It does not fit the normal distribution. In order to make the date comparable, exchange the date (here get the LN of SOCC). After exchange, the significance of Shapiro–Wilk is 0.120, more than 0.05. So we accept the null hypothesis (LN of SOCC fit the normal distribution).

As the data represent different physical meaning, there is a dimension difference. This difference dimension is the main factors that affect overall evaluation of things. In order to make the data comparable, exchange each score to Z score. The result is shown in Table 133.4.

133.3.2 Correlation Analysis

Correlation analysis of standardized data is conducted. In this paper, Pearson correlation of each subscale is computed. The result is shown as Fig. 133.1

The result shows that the Pearson correlation index between Zcore (SOAA) and Zcore(EC) is 0.654, significance is 0.000. So the conclusion that there is apparent positive correlation between efficiency consciousness and academic achievement is not hard to get. Both the significance of Pearson index between Zcore(SOAA) and Zcore(SOCP), Zcore(SOAA) and Zcore(SOHP) are 0.000. SOCP and SOHP are apparent positive correlation with academic achievement. The following model can be easily made.

$$\mathrm{Zcore(SOAA)} = \mathrm{f[Zcore(SOCP),\ Zcore(SOHP)]} \tag{133.1}$$

Table 133.4 Z scores of each subscale

ZSOAA	ZSOIT	ZSOCP	ZLNSOCC	ZSOHP	ZSOHB	ZEC
1.060	0.479	0.623	−1.550	−0.075	0.639	0.110
1.052	−0.415	0.623	2.195	1.494	−0.835	0.912
0.938	−0.863	−0.300	−1.097	0.318	−0.540	−0.692
0.866	1.374	1.546	1.935	2.279	0.049	2.015
0.786	1.374	0.315	−0.282	0.710	0.639	0.711
0.781	1.374	0.930	0.768	1.102	0.344	1.213
0.760	−1.310	0.007	0.089	0.318	−0.246	−0.291
0.739	0.927	0.623	0.089	0.318	−1.425	0.010
0.659	0.032	0.315	1.379	0.318	−2.309	−0.191
0.568	−0.863	1.854	−1.097	−0.467	−0.835	−0.291
0.354	1.374	1.854	0.089	−0.467	−0.540	0.611
0.317	0.927	0.623	−0.282	−0.467	0.933	0.511
0.187	1.374	0.007	0.089	1.494	0.933	1.012
0.082	−0.863	−0.300	0.438	−1.251	0.639	−0.291
0.071	0.032	−0.608	0.089	−0.075	−1.130	−0.592
0.035	−0.863	−0.916	−0.676	−0.467	0.049	−0.793
−0.099	0.479	0.315	−0.282	0.318	0.639	0.411
−0.118	0.927	0.930	−0.282	1.102	0.344	0.812
−0.217	−1.310	−2.147	−0.676	1.102	−1.130	−1.294
−0.228	0.032	0.930	0.438	0.710	0.933	0.912
−0.288	0.032	−1.224	−2.039	−0.467	−0.835	−1.294
−0.346	0.479	0.007	0.438	−0.075	0.933	0.511
−0.405	1.822	0.315	−0.676	−0.859	0.344	0.210
−0.493	−0.415	−0.608	0.089	−0.075	1.228	0.110
−0.507	−0.415	−0.300	0.438	−0.467	−0.540	−0.392
−0.585	−0.415	−1.224	−0.282	−1.251	−1.130	−1.294
−0.690	0.927	0.007	0.438	−0.859	−0.835	−0.191
−0.924	−1.310	−1.531	−2.039	−1.644	0.049	−1.695
−1.127	0.032	−0.916	−0.282	−1.251	−0.540	−0.893
−1.132	−1.310	−1.224	−1.550	−0.467	−0.540	−1.394
−1.152	0.032	0.007	−1.097	−1.251	−1.720	−1.194
−1.306	−0.415	−1.224	0.089	−0.467	−0.246	−0.692
−1.332	−2.205	−1.531	−1.550	−1.644	−0.540	−1.996
−1.394	−1.310	0.007	0.768	0.710	−0.246	0.010
−2.071	−1.310	−1.531	0.438	−1.251	0.344	−0.893
−2.674	−0.415	−0.916	0.089	−2.036	0.933	−0.592

133.3.3 Regression Analysis

Regression analysis is through the provisions of the dependent variable and independent variables to determine the causal relationship between the variables, and established a regression model, according to the measured data to solve the model for each parameter. And then evaluate whether the regression model fits the

		Zscore(SOAA)	Zscore(SOIT)	Zscore (SOCP)	Zscore (SOHP)	Zscore (SOHB)	Zscore (LNSOCC)	Zscore(EC)
Zscore(SOAA)	Pearson Correlation	1.000**	0.390**	0.656**	0.698**	0.197**	0.363**	0.654**
	Sig. (2-tailed)		0.011	0.000	0.000	0.211	0.018	0.000
	N	42	42	42	42	42	42	42
Zscore(SOIT)	Pearson Correlation	0.390**	1.000**	0.584**	0.341**	0.130**	0.227**	0.600**
	Sig. (2-tailed)	0.011		0.000	0.027	0.411	0.149	0.000
	N	42	42	42	42	42	42	42
Zscore(SOCP)	Pearson Correlation	0.656**	0.584**	1.000**	0.539**	0.281**	0.468**	0.822**
	Sig. (2-tailed)	0.000	0.000		0.000	0.072	0.002	0.000
	N	42	42	42	42	42	42	42
Zscore(SOHP)	Pearson Correlation	0.698**	0.341**	0.539**	1.000**	0.252**	0.571**	0.759**
	Sig. (2-tailed)	0.000	0.027	0.000		0.107	0.000	0.000
	N	42	42	42	42	42	42	42
Zscore(SOHB)	Pearson Correlation	0.197**	0.130**	0.281**	0.252**	1.000**	0.256**	0.596**
	Sig. (2-tailed)	0.211	0.411	0.072	0.107		0.102	0.000
	N	42	42	42	42	42	42	42
Zscore(LNSOCC)	Pearson Correlation	0.363**	0.227**	0.468**	0.571**	0.256**	1.000**	0.716**
	Sig. (2-tailed)	0.018	0.149	0.002	0.000	0.102		0.000
	N	42	42	42	42	42	42	42
Zscore(EC)	Pearson Correlation	0.654**	0.600**	0.822**	0.759**	0.596**	0.716**	1.000**
	Sig. (2-tailed)	0.000	0.000	0.000	0.000	0.000	0.000	
	N	42	42	42	42	42	42	42

Fig. 133.1 Correlation analysis of each subscale

measured data well or not, if a good fit, according to the independent variables for further prediction.

Through regression analysis, the factors can be determined as independent variables and as dependent variables predict whether the object concerned, the size of relevant degree, as well as the relevant degree of confidence judgments of size. In this paper, set the Zcore(SOAA) as the dependent variable, Zcore(SOIT), Zcore(SOCP), Zcore(SOHP), Zcore(SOHB), Zcore(LNSOIT) as the independent variables. Use the method of stepwise to conduct regression analysis. The results are shown in Tables 133.5, 133.6 and 133.7.

Form the result of Table 133.5; we can see there are 2 models that fit the regression result. Form the significance of coefficients, SOHP firstly enters the regression equation, SOCP secondly enter. This means that SOHP influence SOAA most, then SOCP second. The model summary is shown in Table 133.6.

Form the result of Table 133.6. We can see in model 1: correlation coefficient between Zscore(SOHP) and Zscore(SOAA) is 0.698, coefficient of determination (r square) is 0.487. That means SOHP determine 48.7 % of SOAA. In model 2: multiple correlation coefficients are 0.773. Coefficient of determination(r square) is 0.597. That means SOHP and SOCP determine 59.7 % of SOAA.

The coefficients of regression are shown in Table 133.7.

The constant should not be in the regression equation. The equation is shown as follows:

$$\mathrm{Zscore(SOAA)} = 0.485 * \mathrm{Zscore(SOHP)} + 0.349 * \mathrm{Zscore(SOCP)} \qquad (133.2)$$

The result fit the correlation analysis in correlation analysis.

Table 133.5 Variables Entered/Removed

Model	Entered	Removed	Method
1	Zscore(SOHP)	.	Stepwise (Criteria: Probability-of-F-to-enter <= 0.050,
2	Zscore(SOCP)	.	Probability-of-F-to-remove > = 0.100).

Table 133.6 Model Summary

Model	R	R square	Adjusted R square	Std. error of the estimate
1	0.698[a]	0.487	0.474	0.72503822
2	0.773[b]	0.597	0.577	0.65065700

[a] Predictors: (Constant), Zscore(SOHP)
[b] Predictors: (Constant), Zscore(SOHP), Zscore(SOCP)

Table 133.7 Coefficients of Regression

Model		Unstandardized coefficients		Standardized coefficients	t	Sig.
		B	Std. error	Beta		
1	(Constant)	1.030E-15	0.112		0.000	1.000
	Zscore(SOHP)	0.698	0.113	0.698	6.164	0.000
2	(Constant)	7.152E-16	0.100		0.000	1.000
	Zscore(SOHP)	0.485	0.121	0.485	4.023	0.000
	Zscore(SOCP)	0.394	0.121	0.394	3.266	0.002

133.4 Discussion

The sense of happiness is a metal joyful, is a satisfaction of psychological. It means weather a student feels fun in study.

Competition is the pressure and motive power that nature given by the rule of survival of the fittest. It can arouse a person's potential, improve study and work efficiency. It means weather a student has the sense to join in the competition, how to face the competition. Competition includes vertically competition and horizontally competition. Vertically competition is the way that competes to oneself whereas horizontally competition is the way that competes to others. A good example for vertically competition is that one thinks that he must do better than yesterday. The sense of competition makes the participants to compare with each other, evaluate the participant objectively, finds out the weakness, overcomes it and improves oneself.

$$\begin{aligned}&\text{The regression equation is Zscore}(\text{SOAA})\\&\quad = 0.485 * \text{Zscore}(\text{SOHP}) + 0.349 * \text{Zscore}(\text{SOCP}).\end{aligned} \tag{133.3}$$

The SOHP influence the SOAA most, SOCP second. That is to say, for IE students, it is important to foster the SOHP and SOCP. For IE educators, foster students' competition sense and make they feel happy can obviously increase the academic achievement.

133.5 Conclusion

Results showed that the differences in efficiency consciousness have effect on IE students' academic achievement. There is apparent positive correlation between SOHP, SOCP of IE students and their academic achievement. There is no obviously relationship between SOCC, SOIT, SOHB of IE students and their academic achievement. Moreover, sense of happiness and sense of competition play the most important role in students' achievement. These findings clearly support the view that efficacy consciousness plays an important part in students' achievement.

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Chapter 134
Application Research of Modified K-Means Clustering Algorithm

Guo-li Liu, You-qian Tan, Li-mei Yu, Jia Liu and Jin-qiao Gao

Abstract This paper presents an efficient algorithm called K-harmonic means clustering algorithm with simulated annealing, for reducing the dependence of the initial values and overcoming to converge to local minimum. The proposed algorithm works by that K-harmonic means algorithm solves the problem that clustering result is sensitive to the initial valves and simulated annealing makes the clustering jump out of local optimal solution at each iteration patterns. The clustering result is verified by experiments on analyzing IRIS dataset. The school XunTong is application software that is convenient to communication between parents and teachers. This paper applies the new algorithm to analysis of dataset in School XunTong and finds the relationship of students' achievement and the communication between parents and teachers. Finally, the result of classification guides the learning direction of students in universities and cultivates to students.

Keywords K-Harmonic means · Simulated annealing · Local minimum · School XunTong

134.1 Introduction

Among these commonly used clustering algorithm, K-means algorithm is typical clustering algorithm and widely used due to its simplicity and high effectiveness. However, it has some problems on the dependence of initial value and the local convergence of clustering result. There are several methods to improve this algorithm: first, apply K-means algorithm to cluster many times and choose the optimum as a final clustering results; second, research the new algorithms. To

G. Liu (✉) · Y. Tan · L. Yu · J. Liu · J. Gao
Department of Computer Science and Software, Hebei University of Technology, Tianjin, China
e-mail: lgl6699@163.com

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improve k-means algorithm for the initial value and local convergence, this paper puts forward a new algorithm based on the combination of K harmonic mean algorithm and simulated annealing (SA) algorithm. "School XunTong" is application software to provide a service to students' parents and involves some information about students. In this paper, the new algorithm is used to cluster the set of "School XunTong", and to find potential relationships of clustering result.

134.2 Fundamental of Algorithm

134.2.1 K-Means Algorithm

K-means algorithm(KM) is a common clustering algorithm based on classification and the oldest classical algorithm (Chiang et al. 2011). In cluster analysis we assume that we have been given a finite set of points X in the d-dimensional space R_d, that is, $X = \{x_i | x_i \in R^d, \quad i = 1, 2, \ldots\ldots, n\}$. K-means algorithm sets date set matrix X into a given number k of isjoined subsets $C_1, C_2, \ldots\ldots, C_k$. An optimal clustering is a partition that minimizes the intra-cluster distance and maximizes the inter-cluster distance. In practice, the most popular similarity measure is Euclidean distances due to its computational simplicity. Euclidean distances is defined as

$$d(i,j) = \sqrt{\left[(x_{i1} - x_{j1})^2 + (x_{i2} - x_{j2}) + \cdots + (x_{id} - x_{jd})\right]} \tag{134.1}$$

subject to

$$i = (x_{i1}, x_{i2}, \ldots, x_{id}) \in R_d \text{ and } j = (x_{j1}, x_{j2}, \ldots, x_{jd}) \in R_d$$

We remark the cluster at each iteration. The updating of cluster centers is that

$$c_i = \frac{1}{n} \sum_{x \in c_i} x \tag{134.2}$$

Where $x = (x_{i1}, x_{i2}, \ldots, x_{id})$.

The main idea behind the K-means algorithm is the minimization of an objective function usually taken up as a function of the deviations between all patterns from their respective cluster centers. The sum of squared Euclidean distances measure has been adopted in most of studies as the objective function. It is as follows,

$$E = \sum_{j=1}^{k} \sum_{i=1}^{n} d_{ij}(x_i, c_j) \tag{134.3}$$

K-means algorithm is simple and efficient, and has good flexibility for large data, however, k-means has its limitations such as the clustering is extremely sensitive to the initial values and it always converges to local minimum (Lai et al. 2009; Jinlan et al. 2005; Pena et al. 1999). K-harmonic means algorithm solves the problem that clustering result is sensitive to the initial valve.

134.2.2 K-Harmonic Means Algorithm

K-harmonic means (KHM) is a center-based algorithm that has been developed to solve the clustering problem (Heng and Wan-hai 2004; Güngör and Ünler 2007; Güngör and Ünler 2008; Zhang and al 2000). This algorithm uses harmonic average of distance from each data point to the cluster center, instead of the minimum distance in K-means algorithm. The harmonic average is defined as

$$\frac{k}{\sum\limits_{c \in C} \frac{1}{d^p(x,c)}} \tag{134.4}$$

where $x \in X$ denotes a finite set of points X in the d-dimensional space R_d, $c \in C$ denotes the cluster centers, $d^p(x, c)$ denotes distance between two points, k denotes the groups of clusters.

The iterate method of cluster center is that:

$$c_k = \frac{\sum_{i=1}^{n} \frac{1}{[\sum_{j=1}^{k} \frac{d_{ik}^p}{d_{i,j}^p}]^2} x_i}{\sum_{i=1}^{n} \frac{1}{[\sum_{j-1}^{n} \frac{d_{ik}^p}{d_{i,j}^p}]^2}} \tag{134.5}$$

where d_{ik}^p denotes the distance between $x_i$and x_j.

The iterate of cluster center constantly minimizes the objective function, the objective function is:

$$\sum_{i=1}^{n} \frac{k}{\sum_{c \in C} \frac{1}{d^p(x,c)}} \tag{134.6}$$

Objective function in KHM algorithm also introduces conditional probability of cluster center to data points and dynamic weights of data points in each iterate process (Güngör and Ünler 2007). KHM algorithm improves the weakness that K-means algorithm is sensitive to the initial values. However K-means still converges to local minimum. Heuristic algorithms as known have very good optimal features (Likas et al. 2001), in paper, we use simulated annealing algorithm to solve local minimum problem of K-means algorithm.

134.2.3 Simulated Annealing

Simulated annealing (SA), presented by Metropolis Rosenbluth (Wei-min et al. 2008; Kirkpatrick et al. 1983; McErlean et al. 1990) and others in 1953, is an iterative method for finding approximate solutions to intractable combinatorial optimization problems.

Simulated Annealing solution methodology resembles the cooling process of molten metals through annealing. The cooling phenomenon is simulated by controlling a parameter, namely, temperature T introduced with the concept of the Boltzmann probability distribution. Metropolis suggested a way to implement the Boltzmann probability distribution in simulated thermodynamic systems that can also be used in the function minimization context. At any instant the current point and the corresponding function value at that point (x_1). Based on Metropolis algorithm, the probability of the next point (x_2) depends on the difference in the function values (ΔE) at these two points. There is some finite probability of selecting the point x_2 even though it is worse than the point x_1 and depends on relative magnitude of ΔE and T values. The optimal solution is obtained by simulating slow cooling, that is, by sampling repeatedly (Kirkpatrick et al. 1983).The initial temperature, cooling rate, number of iterations performed at a particular temperature and the condition of stopping are the most important parameters which governs the success of the Simulated Annealing procedure.

Simulated Annealing solves problem that k-means always converges to local minimum. To solve the shortcomings of dependency on the initial state and the convergence to local optima of k-means, the paper proposed a new algorithms called K-harmonic means clustering algorithm with simulated annealing.

134.3 K-Harmonic Means with Simulated Annealing Algorithm

134.3.1 Algorithm Theory

K-harmonic means clustering algorithm with simulated annealing is the combination of K-harmonic means and simulated annealing, parameters in new algorithm need to be set depending on the features of new algorithm. The main idea of SAKHM (K-harmonic means clustering algorithm with simulated annealing) is that make the data set clustering result derived form K-harmonic means as the initial value of simulated annealing algorithm, the generation of new value in simulation of the iterative process is obtained by random disturbance for current value. That is, randomly changes one of several clustering sample's category, generates a new clustering division, so that the algorithm may jump out of the local minimum value, play the global optimal ability, finally obtain the global optimal clustering results which is not affected by the initial value.

The steps of SAKHM algorithm are:

1. Initialize initial temperature t_0, final temperature t_m, number of inner circulation iterations *MaxInnerLoop*, cooling rate DR.
2. Apply k-harmonic algorithm to the new presented algorithm, each point in set is divided to the point's closest center due to the minimize distance. Compute the centroid for each cluster to obtain a new cluster and the objective function $J(1)$. The clustering result is as the initial solution w.
3. Let variable of inner circulation *InnerLoop* be 0, initialize counting variable of external circulation i.
4. Perform the iteration to generate the improved set of cluster, update the cluster center $w(i)$, compute the new object function of the new iteration that obtain a new set of cluster $J(i+1)$, if $J(i+1) < J(i)$, the cluster centers are accepted, if $J(i+1) >= J(i)$, we will compute the relative magnitude of ΔJ and T due to $P = \exp(\frac{J(i+1)-J(i)}{st(i)})$, namely, $p = \exp(\frac{\Delta J}{sT})$, where $t(i)$ stands for current temperature, s stands for constant,let r be random probability such that $r \in [0, 1]$, if $p >= r$, the new cluster centers is accepted, else, the previous cluster centers continue to iterate;
5. if *InnerLoop* < *MaxInnerLoop*, parameter *InnerLoop*

plus to 1, i plus to 1, if or $i < MaxLoop$, then go to step 4); else, go to step 6;

6. if $t(i) < t_m$, stop the program, else, use formula $t(i+1) = DR * t(i)$, then go to step 3).

134.3.2 K-Harmonic Means Clustering Algorithm with Simulated Annealing base on DK-t_0

K-harmonic means clustering algorithm with simulated annealing focus on applying Simulate Annealing solution methodology to K-means algorithm and setting the key parameters of the new algorithm, the following four aspects tell how to set parameters. It is important to note that such strategies may significantly impact the performance of the new presented algorithm (3), (4) are the key of the paper.

1. The choice of the objective function

The sum of squared Euclidean distances measures has been adopted in the algorithm.

2. Update way of temperature

This algorithm uses cooling rate presented by Kirkpatrick and others to control decrease temperature. Let DR be cooling rate, where DR closes to constant 1. The formula of updating temperature defines as $T(k+1) = DR*T(k)$, k is the updating number of temperature. The cooling speed of temperature is controlled by the parameter DR. This paper sets DR $= 0.98$.

3. Generating the initial temperature

In the simulated annealing algorithm research, the selection principle of initial temperature is: at the beginning of the annealing, temperature has to be high enough to move to any state. But if temperature is too high, it will all make the difference result as new result for a while, and influence the algorithm's effect. So through repeatedly experimenting, initial temperature is determined by new value‘s proper proportion.

Although scholars have proposed many initial temperature setting methods, there is no unified and more effectively method to set the initial temperature. In simulated annealing algorithm the set of initial temperature T_0 corresponds to the set of initial values of control parameters in SAKHM algorithm. On the basis of existing researches, this paper put forward a method to select initial value t_0 of control parameter. The concrete content as follows:

According to the theory of balance, the initial value of control parameter t_0 should be selected big enough. If the probability of initial value is assumed as v_0, According to Metropolis Acceptance criteria, $\exp(\frac{-\Delta J}{at_0}) \approx 1$. To make the formula to be set up, the value of t_0 should be big enough, but if the value of t_0 is too large, it will increase iteration times and computing time. The best selection of t_0 can ensure algorithm to get minimum of global optimal solution. Kirkpatrick and others proposed a method to select initial temperature, called experience method. First, a great value is selected as t_0 and transformed several times, if Accept rate v is less than scheduled initial accept rate v_0 (usually take 0.8), t_0's value double until $v > v_0$. In the paper, we use the method of the combination of experience method and the objective function of K-harmonic means clustering to select t_0. The method is as follows: First, make the objective function of K-harmonic means clustering as t_0' value. Then according to the above method, transform several times, if accept rate $v < v_0 (v_0 = 0.8)$, t_0's value double, until $v > v_0$, at this time, t_0 is the request value; If accept rate $v > v_0 (v_0 = 0.8)$, t_0's value is in half, until $v < v_0$, at this time, t_0 is the request value, This can take to meet the conditions of minimum value. Because the selection of t_0 is associated with the experience method and objective function of K-harmonic means clustering, it is called DK-t_0 selection method.

4. How to generation new solution

In order to make the algorithm balance in the beginning of the algorithm, k-harmonic divides date set into several cluster and clustering results are as initial solutions. In next simulated iterative process, because the calculation amount of k-harmonic is very large. To reduce the running time of the algorithm, the updating cluster center and objective function are by criterion of k-means for the following iterative process and we will also get a good clustering result.

In K-harmonic means clustering algorithm with simulated annealing, new values are generated by disturbing the current solution, that is, The algorithm will naturally move one or more of these centers into other areas. But initial solutions—the clustering result of k-harmonic—are not clear partitioned into several clusters. In disturbance process, each point should be clear partitioned to the only cluster. To sum up, the data split into different cluster according k-harmonic algorithm and each point is divided to the only cluster with minimum distance principle, calculate the corresponding target function. New algorithm begins with the above clustering result. The generating way of new solution is by disturbing the current solution.

134.4 Validation Based on K-Harmonic Algorithm

In order to evaluate the performance of k-harmonic means clustering algorithm with simulated annealing, applying the new algorithm to IRIS data set. The first one is the Iris data set that has $N = 150$ points that each point has four attributes—calyx long, calyx wide, petals long, petals wide. In this article, the distance between the cluster and actual value is as the evaluation of the algorithm.

Due to distance of data attributes are very different; the date set must be normalized before clustering. After 20 times experiments singly, some main datas are gathered in Table 134.1 including the maximum, minimum and average of algorithm target functions, difference by actual value, and average CPU time. Among them the last two columns are averages of running by 20 times.

From Table 134.1, the running time of K-mean algorithm is least, but different initial value and clustering effect are different obviously. The maximum of target function has biggest difference compared with the minimum, and then it shows that it is highly sensitive for the initial value, and but the difference is very obviously. On the contrary, the algorithm time is increasing obviously of K-harmonic means clustering with simulated annealing, but the change is smaller between target functions, and the difference is small between cluster center and actual center. And then the figure shows the cluster result of the eighth running, the horizontal ordinate shows a length of calyx, the Y-ordinate shows the width of calyx.

Figure 134.2 is the result of SAKHM cluster analysis, compared with KM algorithm from Fig. 134.1 its point set has some intersections, but it hasn't from Fig. 134.1. So it shows the ability of global search and far away from the local minimum base on K-harmonic means.

Table 134.1 Clustering results of KM and SAKHM algorithm

Algorithm	Minimum	Average	Maximum	Error	CPU-time
KM	140.94	175.56	207.06	18.89	0.05
SA-KHM	76.32	79.82	84.98	2.63	16.94

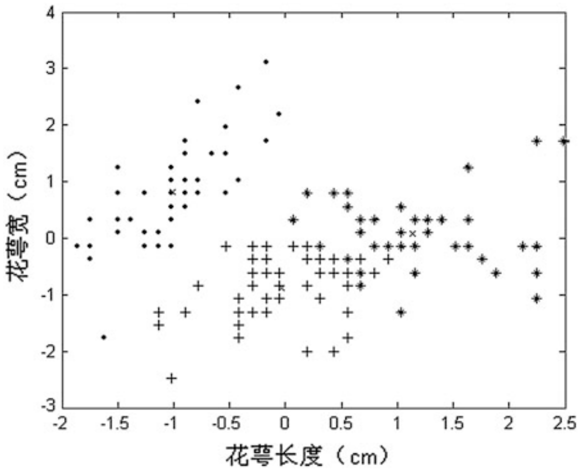


Fig. 134.1 Clustering results of KM algorithm

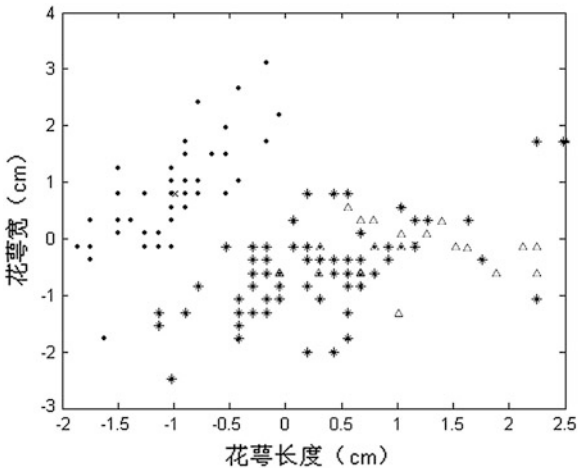


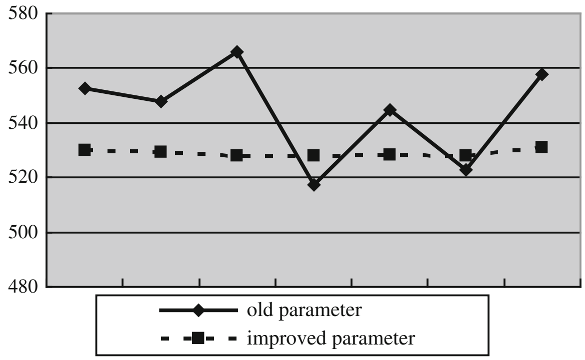
Fig. 134.2 Clustering results of SAKHM algorithm

The experiment collects statistical chart of the first bachelor aspiration of science and engineering in 2009. The data set includes 195 datas that each data has 5 properties: total score, Chinese score, math score, foreign language score, and school level. If a school is 211 colleges the level is second and if it is 985 colleges the level is third, if it is the 34 key universities the level is fourth. The scores of Chinese, math, foreign language are the least scores delivered first.

In the clustering process, the setting of t_0 respectively uses experience method and improved method. To prove this assertion we use an argument similar to that of the new algorithm, based on the same initial assumptions. Each factor combination is tested 7 times with test problems.

Figure 134.3 compares the objective function performance of the above two approaches. The full line and the dotted line represent, respectively, the

Fig. 134.3 Contrast two method s' objective function



unimproved parameter and improved parameter approaches. It can find out a less cluster target function from the DK-t_0. The method based on DK-t_0 selected gets little change of target function, namely the value of target function is more stable, and the new cluster effect is better.

134.5 Applying Improved Algorithm to School Xuntong

In recent years, more and more parents concerned themselves with the situation of their children in school. Certain companies cooperated with Mobile Company and have developed a digital campus system. "School XunTong" is application software that can exchange students' information between parents and teachers conveniently. "School XunTong" mainly targets at primary and middle school students. Teachers can send and receive text messages freely and enjoy Internet service, parents can acquire students' information through customizing business, company can profit from this business too. Because the target customers of "School XunTong" are for primary and middle school students of the whole province or city, it has a large number of complex data. It is difficult to manage and there is little value for the company. With the increasing number of users, the data is growing rapidly. People desire to find useful information from the database of "School XunTong". From this perspective, analysis the database of "School XunTong" using the cluster analysis algorithm becomes very meaningful.

The data to be analyzed come from school database of "School XunTong", which includes more than four hundred students' information from September 2009 to December 2009, the information include students' accounts, parents' accounts, mobile numbers, time of sending message, students' achievements, parents' mobile numbers, message themes, and so on.

The data should be preprocessed before cluster; the process of the preprocessing includes transferring data, processing default value, processing abnormal value, processing isolated points, etc.

Table 134.2 Clustering results of KM and SAKHM algorithm

Variable	Minimum	Average	Maximum	Error
Chinese Score	10	58.67	108.00	20.60

1. The data source has different data types that include numeric, text type, time type, etc. They should be converted to unified data types. For example, the type of grade is converted to numeric; senior school is equal to 10.
2. From the sample datas, there are some default values. And the default value is filled by the right value that usually is the most frequency used.
3. Some datas may be error in statistics, and some can deviate from the data mean obviously, so they become outlier data. For example, some scores are more than 100 or less than 0 and some scores are 5, 10. These scores are far away from the average value. These datas should be obsolete, and then the cluster result will be more effective. Table 134.2 depicts the variable Chinese Score.

In order to ensure the data points in a certain range, developing a standard makes the data points in [58.6667−2.0*20.6009,100]. Beyond the range, the data point called isolated point must be deleted. In Fig. 134.4, there are three scores more than 100, two points is below 58.6667−2.0*20.6009. Then remove these point 104,108,10 and remove all data item corresponding to these point. The rest of the points will be in [58.6667−2.0*20.6009, 100].

4. Some dates must be removed that do not connect with property values such as creation time; it is acceptable for test score, counts of teachers' informations.

Due to the obvious differences in the datas which have different attributes from the data set, in order to not be covered from large value for the small value and lose its key role, and then the data set must be normalized before cluster. That is,

$$x = \frac{x - average}{\max(x) - \min(x)}$$

Fig. 134.4 Diagram of YuwenScore in databset

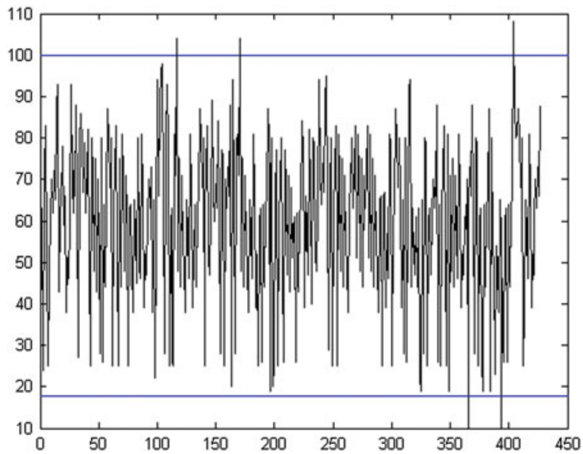


Table 134.3 Cluster center of SAKHM algorithm

	Chinese score	Math score	English score	Avg-score	Life msg	Study msg
1	65.10	71.54	71.80	69.31	8.82	34.39
2	36.61	49.04	46.42	43.77	9.21	35.83
3	76.14	47.53	38.79	54.00	8.10	34.78

The new algorithm is applied to the data set of "School XunTong". Let parameters k $= 3$, $t_0 = 0.00001$, $t_m = 48$, $MaxInnerLoop = 6$, $MaxLoop = 1000$, and then the new algorithm splits a 428-pattern data set into three, each cluster respectively obtains 258,108,62 points. The clustering result shows in Table 134.2.

The cluster is transferred to original data form as the following:

According to the data results of Table 134.3, this article will analysis the cluster result of the School XunTong's data set based on the K-harmonic means cluster algorithm.

Sort first: the data set includes 258 data items, 60 % of total students belong to this sort. According to the clustering result, the scores of the students in the cluster are better, more stable and have not learning branches. From the extent of communication between parents and teachers, compared by other clusters, the messages from teachers are less than students' about learning and life. In one word, teachers send a few text messages.

Sort second: the data set includes 108 data items, and it is 25 % of the counts of total students. According to the clustering result, the students haven't learned branches obviously, but the average scores are less. From the extent of communication between parents and teachers, compared by other clusters, the messages from teachers are more than students' about learning and life. In these sorts, messages from teachers are most.

Sort third: the data set includes 62 data items, and it is a rarely part of the total. According to the Analysis of the clustering result, Chinese is very good, math is medium, English is poor, average scores are low. Life messages from teachers are far less than learning messages.

According to the above analysis, the teachers actively send far more messages than parents' replying messages which are mainly about learning. From analysising the clustering result, enterprise can target on the parents of those students who got poor academic achievement. Life information of good students is a key point for enterprise to persuade parents to open text message service. Enterprise also can analyze the characteristics of customer group and set up new business. The school can effectively use the analysis: Good students can have comprehensive development; Students that tend to be unbalanced on one or some subjects should learn weak courses and can rapidly improve scores; Teacher should pay more attention to students whose academic achievements are poor, and try to help them in each subject. The students can make great achievement in a short time.

134.6 Conclusion

Inspired by observation that shortcomings that are sensitive to start point and alway converge to local minimum of k-mean are essentially solved, this work presents an efficient algorithm, called K-harmonic means clustering algorithm with simulated annealing. Applying the new algorithm to IRIS date set, our experimental results indicate that the proposed algorithm obtain results better than those of k-means. Efforts are underway to apply the proposed algorithm to “School XunTong” in order to find potential relationship between students’ achievement and the communication between parents and teachers and guide students to study.

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Chapter 135
College Admission Mode of Multiple Choices Based on Internet

Zhao-tong Wu, Li-ping Fu and Rui-xue Zhao

Abstract As an important constituent of education system in China, the reform and development of College Entrance Examination (CEE) are supposed to be guided under the concept of scientific development, so as to "provide each student with a suitable education". In recent years, the reform of college admission system has been so greatly improved that the rights and interests of the student-applicants are better protected, though much effort is still needed in accordance with "student-oriented". This thesis, on an analysis of pros and cons upon the current methods of college choosing and student enrolling, has proposed an innovative, internet-based way of admission mode for colleges. The core of this mode is established on multi-application submitting to fully protect the rights and interests of students. With the rapid development of society in China, the mode will be one of the expecting ways in reforming CEE.

Keywords College entrance examination enrollment (CEEE) · Internet · Multi-application

135.1 Introduction

As an important constituent of the educational system, the reform and development of College Entrance Examination (CEE) is supposed to follow the concept of scientific development and be examinee-oriented, so as to "provide each student

Z. Wu (✉)
School of Marxism, Tianjin University, Tianjin, China
e-mail: Snow14princess@hotmail.com

L. Fu · R. Zhao
Research Center for Public Resource Management, School of Management,
Tianjin University, Tianjin, China

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with a suitable education" (Zhong et al. 2004). In the process of reformation, respecting individuality, giving students more space of growth and helping students develop in an all-around way, are the principles we are pursuing. In recent years, the reform of CEE has been greatly accelerated, and a lot of endeavor has been done both on the examination evaluation system and admission system.

As for the enrolment, the Ministry of Education has allowed some colleges to enroll students independently since 2003. Until 2010, 80 universities have begun the independent enrollment. In addition, multi-ways of enrollment such as enrollment by recommendation, directional enrollment and the special granted enrollment are gradually being available, which means both colleges and students have more choices (Du and Zhang 2006). However, the ways of enrollment we mentioned are only available among a very few examinees. The majority of students have to take the CEE. After ranking by their scores, they can be accepted into colleges. In 2008, the Ministry of Education called for innovations in the candidates' information dealing process and advised departments of Education in local provinces to carry out parallel college-applying admission (Fu et al. 2011). In recent years, more and more provinces have begun to implement the policy of submitting applications when knowing the scores and ranks of candidates. The parallel college-applying submission effectively reduces the risks in applying for the students. However, there are still some problems, for example, how to help the candidates develop in all-around way effectively; how to guarantee equal opportunity to enter college for each student; how to satisfy students' needs of major preferences, so that students can have a more free and individual way to develop (Nie 2007). This thesis, on an analysis of pros and cons upon the current methods of college choosing and student enrolling, has proposed an innovative way of admission mode for colleges. Due to the limitation of space, this thesis merely takes account of students who take the unifying entrance examination, and assumes CEE's scores as the only references of college admission, not including the issue of evaluation of comprehensive quality.

135.2 The Frame Work of College Admission Mode of Multiple Choices Based on Internet

At present, there are three ways of college-application submitting in China according to the submitting time: submitting before the CEE, submitting after estimating on CEE scores and submitting after knowing the CEE scores; and according to the ways of gathering archives' information, there are ordered college-applying admission and parallel college-applying admission. Despite the fact that all ways of application submitting share advantages of their own, the flaws are also ominous (Outline of the National Meddle and Long Term Plan for Education Reform andDevelopment 2010–2020). In order to enable students have more choices, I put forward an Internet-based mode of multi-application submitting, in expect of solving the mentioned disadvantages.

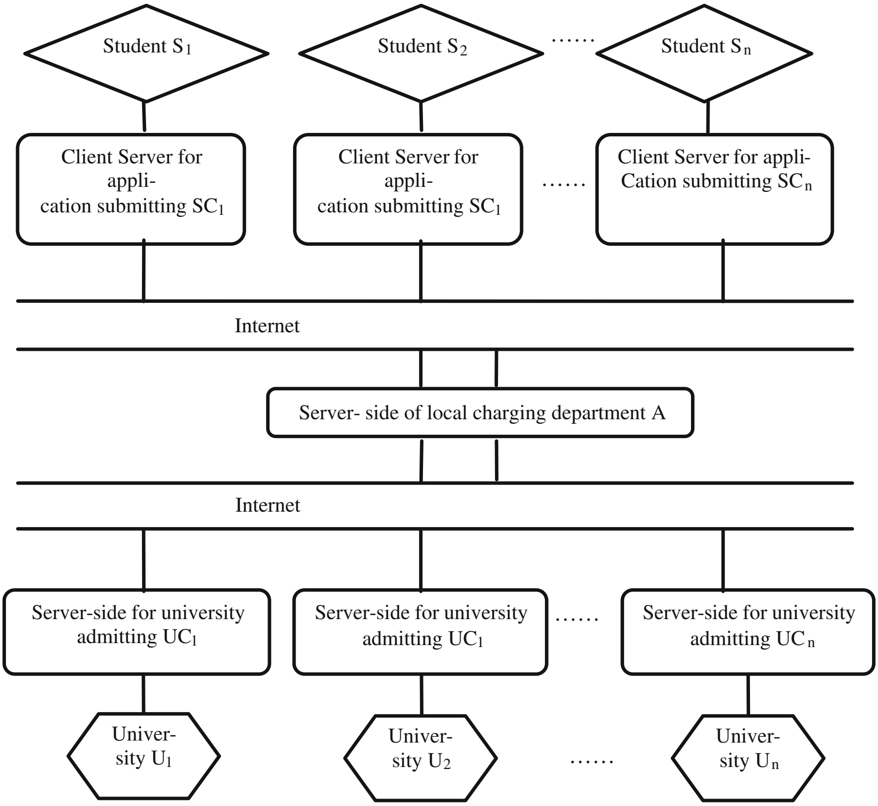

Fig. 135.1 Framework of CAMMCBI

College Admission Mode of Multiple Choices Based on Internet (CAMMCBI) is an admission mode based on the Internet and students oriented, whose framework is shown in Fig. 135.1.

Taking account of the various admission lines in different regions, we'll illustrate the example in one single province shown in Fig. 135.1. The internet functions as a bridge between colleges and students and the connection can be easily built just through one net connected computer.

As for the client-side for submitting, users can log in the system for application processing as long as submitting the right user's name and the keywords, and then, they can submit the final application after filling in and checking personal information and other data (Liu 2002). The system also has pre-installed information such as the admission batch, the recruiting plan, introduction about colleges and majors, requirements for the applicators, requirements by the charging departments and attentions. As for the server-side for enrollment, relevant systems for recruiting must be pre-installed. Users also log in by submitting their name and keywords, and then they can read the detailed information of all the applicants who submit to the colleges, including the information of the college and major they are interested in. As for the server-side in the charging department, it will function as an agent, which also plays an essential part in the whole process of enrolment. In addition to the fundamental functions, the system is supposed to share a series of additional functions, for example, delivering electronic archives, printing enrollment list, application confirming and so on (Li 2001). This mode is mainly established on the computer and its connection with the internet, so an unobstructed, steady and safe network is the presupposition of successful operation. In addition, the correct way of using all server or client side of the system plays a crucial role.

135.3 The Operating Procedure of CAMMCBI

In order to have a better illustration, now we set the following assumptions: (1) the admission mode can be only applied under the first batch of admission, not covering other batches; (2) every student can only apply for m (m is an integer, ≥ 1) colleges and 1 major from each college; (3) the final admission depends on the score of the applicants; (4) assume that net connected computers are available for all the applicants, meanwhile applicants can make use of the computers correctly under a steady operation conditions. Based on those four assumptions the operation process of the CAMMCBI is shown as follows:

135.3.1 Pre-Admission Stage

1. After well learning about the colleges and majors, student will submit their applications through the system before the deadline. Their choices of colleges are not ordered, and students only need to select the colleges whose enrollment lines are close to their scores (Li et al. 2010). When the submission is over, all the relevant applying information will be delivered right to the server-side for the local education department.
2. The local education department will deliver applicants' information to the server side of each college. We assume that one applicant's information will be delivered to m colleges.
3. Every college downloads the information of their applicants. (In order to avoid spending too long a time downloading, college could choose to mass download in batches classified by the scores).
4. Colleges then begin to partly enroll some of the applicants according to the preset principles (He). For example, if the total enrollments is x in plan, to guarantee the following enrolment, college will enroll a_i^{*x} applicants in the first round (a_i is the admission index, the specific value is the comprehensive results of considering these factors: the admission lines of past years, this year's

planning number of enrolment and the expecting number of applications. Every college has an exclusive a_i, which can't be comparable). Colleges will send pre-admitting information to the qualified students.

5. When colleges complete their first round enrollment, the relevant local education department will issue the notice on the Internet and student applicants can log in the system to check their enrollment. Every student may be admitted by $0 \sim$ m colleges. Due to the different enrollment time length of each college, applicants may have to wait for a period of time. To ensure the steadiness and security of the Internet, the charging department can ask applicants to check information and make the reply within a specified time. Applicants will select one of the colleges and cannot make the change once submitting the final decision (Wang et al. 2012). And then the confirming information will be delivered to the server side of college admitting.
6. College now begins to download the feedback of first round pre-enrollment. Suppose there are y students confirm the admission, college can ask the local department of education to delete their information from the "agent" server side after transforming the information into the database of "have been admitted" students (Wang 2003). Then college will update non-admitted applicants' information, meanwhile save the information of those students who confirm the admission. That's all for the first round admission.

135.3.2 The Second Round Admission

After the first round of admission, most colleges and universities failed to complete the enrollment plan. Now take the above college for example, suppose there are yet $x - y$ quotas of students to be enrolled. Of course, colleges can follow the same procedure as that of the first round. However, because the remaining majors are less attractive to applicants, college needs to reset the admission index. Suppose in the second round of admission, the admission index is b_i, then the total number of enrolment in the second round will be $b_i * (x - y)$, and b_i is usually less than a_i. Some colleges may complete their enrolments through several rounds of admission, when the admission plan is fulfilled, college almost accomplish their entire mission in that province (Wu and Zhong 2012). The following tasks are sending paper admission notice, receiving sanction from local education department. Then that's the end of all procedures.

The connotation of those sequence number in Fig. 135.2 is shown as follow:

1. Sending application information to the local education department (mid June–late June)
2. Delivering the information to m colleges (late June–early July)
3. m colleges examining applicants' information (early July–mid July)
4. t of m colleges decide to admit Student S, and sending the admission information to S (mid July–late July)
5. Student S1 choose the College Ux among t colleges (late July–early April)

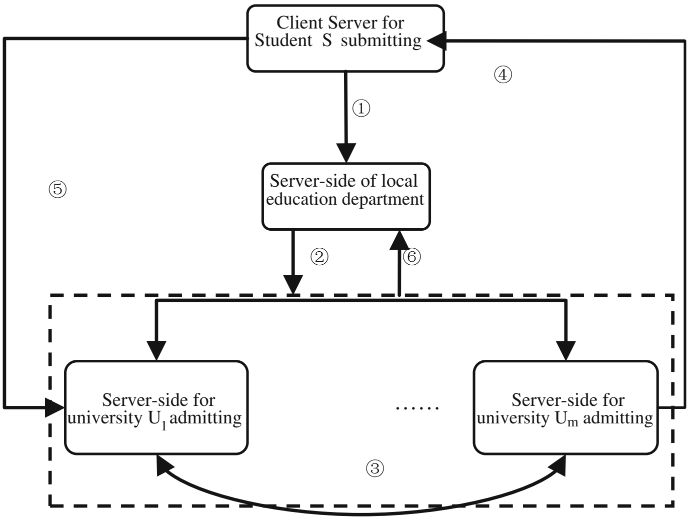

Fig. 135.2 Flowchart of CAMMCBI

6. College Ux asks the local education department to delete information of Student S1 from the server, when information is completely transferred to its server side.

135.4 Analysis on the CAMMCBI

It's easy for student applicants to handle this mode of applying, which can greatly reduce the proportion of failed application and ensure students' right to enter university. Meanwhile, it's also easy for colleges to implement the admission procedure, which ensure colleges to able to enroll well qualified students. In spite of that, this mode lengthens the time of enrolling, increases the workload, and reduces the efficiency. So how to set the limitation of number of submission to either college or major is the key problem to solve currently. The advantages and disadvantages of CAMMCBI are shown as follows:

135.4.1 The Strength of CAMMCBI

1. Fully reflects the spirit of "People oriented"

The new mode focuses on the students. Students have their own interests and talents, strength and personalities, profession preferences and career plans. The mode offers a not very strict environment, in which there are more choices, more chances of participating and more respect for individual growth. When students devote themselves to the higher learning and extracurricular activities with relaxed nerves, happy mood and vibrant thoughts, their potential can be best exploited. And for colleges and universities, this mode adds the transparency in publicizing information, which in return, reduces the amount of workload and pressure as the result of applying this system (Yuan 2006). In addition, colleges become more independent to enroll better qualified students.

2. In terms of economical society, CEEAMMCBI are more resources-conserved

At present, in most provinces and cities, application is filled on paper materials, even online applications require paper ones of confirmation. While in CAMMCBI, except the admission notice, no other messages are transferred with paper material. At the same time, high enrolling rates leads to low examination retaking rate in senior school, which effectively reduces the cost of education either in economy or time. In the other term, many conservative students now have a chance of gambling in applying for better colleges, avoiding those colleges' possibility of vacant enrollment and making good use of educational resources.

3. Effectively stopping the non-approved admission and illegal agents

Based on the unified enrollment platform, referenced admissions plan, CAMMCBI can effectively prevent the fraud enrollment and the non-approved admission. As CAMMCBI is a dynamic system, in which students and colleges are connected only by provincial education department, it can limit the activities of illegal agents to ensure the rights and interests of majorities.

4. Easy to implement in the nationwide

CAMMCBI is established on the Internet and relevant software system. With the popularity of Internet and the development of society, CAMMCBI can equally guarantee most provinces, large or small, developed or developing, to process under one unified admission platform. In 2007 the Inner Mongolia Autonomous Region successfully realized the first batch of undergraduate colleges online applying. 16,990 participated in and the whole process ran quite well. This practice in this western province best verifies that online application is feasible.

135.4.2 The Weakness of CAMMCBI

As a brand new way of admission, CAMMCBI inevitably has some weaknesses to be solved. For example: how to set the time of first round of admission, how to determine the admission index, how to organize staffs efficiently and how to guarantee the equity in the process. In this thesis, we believe that among these problems, the priority is to make sure how many colleges and majors each student is limited to apply. If so or there is a way to solve these two problems, the strength of CAMMCBI will be fully realized.

135.5 Determination on Archives Number

Usually, it is a random process that, under multi-application submitting mechanism, different bands of candidates choose different levels of universities. Since score rating of the candidates is given, last round has nothing to do with multi-application submitting. Therefore, the multi-application submitting process of candidates can be approximated as a Markov process. Markov process is a good description of the sequence changes of the multi-application submitting process of candidates.

Markov assumption means that:

1. The activity that specific candidate delivers his or her wish to any admissions institutions of system only depends on the score level of the candidate.
2. The transfer matrix is approximately stable. That is to say, there is no different transition probability in different candidates or no different transition probability in different time.

In fact, despite the assumptions of the above is demanding, the transfer matrix can approximately meets this "smooth" assumption under the support of the stable multi-application submitting environment and fixed candidates scores. Particularly, for the state of the Markov chain I, if $p_{ij} = 1$, that is: reaching the state I will remain permanently in state I and will not stay or re-transfer to other state. We call that state I absorbing state (Zheng 2001). Similarly, in the process of multi-application submitting, once the candidates accepted the invitation and confirm online, will turn into a formal admission. Its files will be deleted from the enrollment server and no longer involved multi-application submitting.

Based on the analysis and assumptions of the above, we can use the absorbing Markov analysis method to establish the absorbing Markov chain model of the candidates' scores and college level sequence, and analysis CAMMCBI admission mechanism from a dynamic perspective.

For example, the college entrance examination in 2009 (Science) in the city of Chongqing analyzed the data more than 550 points. Set 20 points is a level, from high to low, the data was divided into six levels. Similarly, set 20 points is a level, the data was divided into six levels according to the minimum entry score of 985 institutions in 2009.

For Pareto improvement on the current parallel college-applying admission, CAMMCBI admission mechanism can ensure high acceptance rate of the candidates with high scores, and without large-scale reducing the acceptance rate of the candidates with low scores. Based on CAMMCBI admission mechanism, we believe that:

1. All institutions can be accepted.
2. Candidates have the opportunity to be admitted as long as the institutions are still enrolling, even if scores of the candidates rank are lower than the level of institutions.

3. The coexistence of failed candidates and wasting school admission quota will not occur.

Now do the following provisions: the probability of candidates with more than 650 points but be refused by the institutions which minimum entry scores is more than 650 points is x. The probability of refused ones by the institutions which minimum entry scores between 630 and 650 points is X^2. The probability of be refused by the institutions which minimum entry scores between 610 to 630 points is X^3, and so on. Assume that the probability of candidates with more than 650 points be admitted is equal to the probability of be admitted by the institutions which minimum entry score is more than 650 points. From the above, we can get the following equation:

$$X + X^2 + X^3 + X^4 + X^5 + X^6 + X = 1$$

Solve and get: $X = 0.3825$

The reject-probability of other scores section of the candidates is the same. Ultimately, we can get the transfer matrix in the following Table (135.1):

Converted into the standard form of absorbing Markov chain: $P = \begin{matrix} I & 0 \\ R & Q \end{matrix}$

Among them, Q represents the probability of 6*6 non-absorbing state (has not be admitted by the institutions).

$$Q = \begin{matrix} 0.3825 & 0.1463 & 0.056 & 0.0214 & 0.0082 & 0.0031 \\ 0.4466 & 0.1995 & 0.0891 & 0.0398 & 0.0178 & 0.0079 \\ 0.4764 & 0.227 & 0.1081 & 0.0515 & 0.0245 & 0.0117 \\ 0.4887 & 0.2388 & 0.1167 & 0.057 & 0.0279 & 0.0136 \\ 0.4961 & 0.2461 & 0.1221 & 0.606 & 0.0301 & 0.0149 \\ 0.5 & 0.25 & 0.125 & 0.0625 & 0.0313 & 0.0156 \end{matrix}$$

Table 135.1 Transfer matrix for each grade

Candidates score Level		Enrollment institution level						
		>650	[630,650]	[610,630]	[590,610]	[570,590]	[550,570]	Admission
1	>650	0.3825	0.1463	0.056	0.0214	0.0082	0.0031	0.3825
2	[630,650]	0.4466	0.1995	0.0891	0.0398	0.0178	0.0079	0.1995
3	[610,630]	0.4764	0.227	0.1081	0.0515	0.0245	0.0117	0.1081
4	[590,610]	0.4887	0.2388	0.1167	0.057	0.0279	0.0136	0.057
5	[570,590]	0.4961	0.2461	0.1221	0.0606	0.0301	0.0149	0.0301
6	[550,570]	0.5	0.25	0.125	0.0625	0.0313	0.0156	0.0156
Admission		0	0	0	0	0	0	1

$$\text{So I} - \text{Q} = \begin{matrix} 0.6175 & -0.146 & -0.056 & -0.021 & -0.008 & -0.003 \\ -0.447 & 0.8005 & -0.089 & -0.04 & -0.018 & -0.008 \\ 0.476 & 0.227 & 0.8919 & 0.052 & 0.025 & 0.012 \\ -0.489 & -0.239 & -0.117 & 0.943 & -0.028 & -0.014 \\ -0.496 & -0.246 & -0.122 & -0.061 & 0.9699 & -0.015 \\ -0.5 & -0.25 & -0.125 & -0.063 & -0.031 & 0.9844 \end{matrix}$$

The average step length which from the refused of institutions to reaching the absorbing state: $t = N * c = [1 - Q]^{-1} * c$, among them, c represents column vector with 6 component 1(non-abrobing state(refused)).

$$t = \begin{pmatrix} 2.2712 & 0.5182 & 0.2131 & 0.0885 & 0.0371 & 0.0157 \\ 1.6265 & 1.6955 & 0.2997 & 0.1301 & 0.0569 & 0.0251 \\ 1.8165 & 0.7916 & 1.3484 & 0.1548 & 0.0694 & 0.0314 \\ 1.9002 & 0.8341 & 0.3703 & 1.1662 & 0.0753 & 0.0344 \\ 1.9521 & 0.8605 & 0.3839 & 0.1733 & 1.0791 & 0.0364 \\ 1.98 & 0.8746 & 0.3913 & 0.1772 & 0.0812 & 1.0376 \end{pmatrix} * \begin{pmatrix} 1 \\ 1 \\ 1 \\ 1 \\ 1 \\ 1 \end{pmatrix}$$

$$= \begin{pmatrix} 3.1439 \\ 3.8339 \\ 4.2121 \\ 4.3804 \\ 4.4854 \\ 4.519 \end{pmatrix}$$

As this model has only one absorbing state, and each state are connected. So each non-absorbing state is bound to be absorbed after the transfer of the limited step. Known by the t values, first grade candidates in the range of the highest score submit 3, 1439 times can be admitted. Candidates in the range of the sixth score (between 550 and 570 points) need to submit 4.5419 times in order to be admitted ultimately. In order to ensure the best satisfaction of candidates, we selected 4.5419 as the multi-application submitting times.

It should be noted that 4.5419 is only the average expectation of candidates. Specific to a particular candidate, the number of admission may be greater or less than this average eventually. The same method based on the CAMMCBI admission mechanism can be applied to the number of majors.

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Chapter 136
Application of Weighted Fuzzy Clustering Method to Supplier Selection Under E-Business

Yan Yang, Wei-ping Yang and Yao Liang

Abstract In order to avoid the imbalance among evaluation index in the general fuzzy clustering, using the weighted fuzzy clustering algorithm to choose the best provider under E-business. In this paper, first, the weighted of each index is curtained by AHP, and then the weight is added to the fuzzy clustering algorithm. The F-distribution of probability statistics is used to determine the best classification number, which can help choose the best classification. Finally, comprehensive value is computer by fuzzy synthetically evaluation, through which the best supplier can be selected.

Keywords Analytic hierarchy process · Fuzzy synthetically evaluation · Weight fuzzy clustering · Provider selection

136.1 Introduction

The twenty-first Century is an age of information explosion, information technology and network economy is its enormous power to promote the social economic form the profound transformation, the electronic commerce has become the core of information world and the driving force for the development of network economy. E-business and the rapid development of information technology

Y. Yang (✉) · W. Yang
Department of Industrial Engineering, Kunming University of Science and Technology, Kunming, China
e-mail: xyxy_1340@163.com

W. Yang
e-mail: ywp58@yahoo.com.cn

Y. Liang
Adult Education College, Kunming University of Science and Technology, Kunming, China

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shortens the distance between enterprises and suppliers, to promote enterprise and suppliers of information integration and sharing, changing the enterprise find supplier information and supplier transaction way, affect the transaction cost, safety and reliability. Therefore, establishing the new evaluation standard is to guarantee the successful cooperation, stability of the important premise.

In the traditional research of supplier selection, typical fuzzy clustering algorithm are the method based on similarity relation and fuzzy relation, the maximum tree method based on fuzzy cam and dynamic programming etc. (Ma and Zhang 2009; Gan and Wang 2010). But the traditional algorithm is not considered in the evaluation of various factors of the difference between the, considered in the clustering process of each factor are equivalent (Nan 2010). At the same time, because of the number of suppliers which involved in electronic commerce environment is increasing, through the algorithm step select the best suppliers, will lead to excessive amount of calculation. Therefore, on the basis of considering the above two problems, in this paper, first,the weighted of each index is curtained by AHP, and then the weight is added to the fuzzy clustering algorithm. The F-distribution of probability statistics is used to determine the best classification number, which can help choose the best classification. Finally, comprehensive value is computer by fuzzy synthetically evaluation, through which the best supplier can be selected.

136.2 Establishment of Evaluation Index System

In the era of network economy and the rapid development of e-business environment, the evaluation of supplier information ability should be given enough attention (Schingnar 1980; Huo 2001; Azzone and Rangone 1996). This paper is based on referencing the representative index of traditional supplier selection, specifically from the bright time character, scientific and practical, flexible operation, expansibility, comprehensive system five aspects to carry on comprehensive consideration, try to establish a platform for electronic commerce supplier evaluation and selection index system as shown in Table 136.1 (Chen 2005).

136.3 Identify Weight by AHP

This paper uses the geometric average method to solve the largest eigenvalue λ and the corresponding characteristic vector W of comparison matrix.

$$W_A = [a_1\ a_2\ a_3\ a_4\ a_5]$$
$$W_{Bi} = [b_{i1}\ b_{i2}\ \ldots\ b_{in}]$$

Table 136.1 Index system

Target layer	Rule layer	Index layer
Supplier A	Informationization B_1	Information construction investment ratio C_1
		Computer professionals proportion C_2
		Information sharing integrated ability C_3
		Information security C_4
	Service level B_2	Industry experience C_5
		After-sales service satisfaction C_6
		Historical transaction records C_7
		Brand reputation C_8
		Recycling center processing speed C_9
		Rapid response ability C_{10}
	Business ability B_3	Cost control C_{11}
		Financial status C_{12}
		Supply capacity C_{13}
	Technology level B_4	Technology innovation ability C_{14}
		Production equipment safe operation rate C_{15}
		R&D Investment ratio C_{16}
		Equipment leading level C_{17}
	Enterprise development prospect B_5	Market influence C_{18}
		New product development rate C_{19}
		Training expenditure per capita C_{20}
		Economic and technological environment C_{21}

136.4 Establishment of Weighted Fuzzy Clustering Model

136.4.1 Data Weighted Standardization

Set domain $U = (x_1,x_2,\ldots,x_n)$ to be classified n suppliers, each object has a 5level of evaluation index, according to the problem of the original data matrix:

$$D = \begin{bmatrix} x_{11} & x_{12} & \cdots & x_{1m} \\ x_{21} & x_{22} & \cdots & x_{2m} \\ \vdots & \vdots & & \vdots \\ x_{n1} & x_{n2} & \cdots & x_{nm} \end{bmatrix} \quad \mathrm{m} = 5$$

In practical problems, different data generally have different dimensions. In order to make a different amount of data can be compared, usually need to make appropriate transform data. Therefore, according to the fuzzy matrix requirements for data standardization data compression to the interval [0, 1], the process requires the following transformation (Yingluo 2003):

1. Translation…standard deviation changes:

$$x'_{ik} = \frac{x_{ik} - \bar{x}_k}{s_k} \quad \text{i} = 1, 2, 3, \ldots, \text{n}; \ \text{k} = 1, 2, 3, 4, 5$$

Among them, $\bar{x}_k = \frac{1}{n}\sum_{i=1}^{m} x_{ik}, s_k = \sqrt{\frac{1}{n}\sum_{i=1}^{n}(x_{ik} - \bar{x}_k)^2}$

After transformation, each variable of the mean value is 0, the standard deviation is 1, and eliminate the influence of dimensional, but the X is not necessarily in the interval [0,1].

2. Translation…differential changes:

$$x''_{ik} = \frac{x'_{ik} - \min\limits_{1 \le i \le n}\{x'_{ik}\}}{\max\limits_{1 \le i \le n}\{x'_{ik}\} - \min\limits_{1 \le i \le n}\{x'_{ik}\}} \quad \text{k} = 1, 2, 3, 4, 5$$

$0 \le x''_{ik} \le 1$ is clearly, and also eliminate the influence of the dimension. Then, on the transform results were weighted arithmetic, get:

$$Y = \begin{bmatrix} x''_{11} & x''_{12} & \cdots & x''_{1m} \\ x''_{21} & x''_{22} & \cdots & x''_{2m} \\ \vdots & \vdots & & \vdots \\ x''_{n1} & x''_{n2} & \cdots & x''_{nm} \end{bmatrix} \cdot \begin{bmatrix} a_1 & 0 & \cdots & 0 \\ 0 & a_2 & \cdots & 0 \\ \vdots & \vdots & & \vdots \\ 0 & 0 & 0 & a_m \end{bmatrix} = \begin{bmatrix} x'''_{11} & x'''_{12} & \cdots & x'''_{1m} \\ x'''_{21} & x'''_{22} & \cdots & x'''_{2m} \\ \vdots & \vdots & & \vdots \\ x'''_{n1} & x'''_{n2} & \cdots & x'''_{nm} \end{bmatrix}$$

136.4.2 Establishing Fuzzy Relationship Matrix

According to the traditional clustering method to determine the similarity coefficient, establish fuzzy similar matrix. To determine the similarity $r_{ij} = R(x_i, x_j)$ methods mainly have the traditional cluster analysis of the similarity coefficient method, distance and angle cosine method. In this paper, using the included angle cosine method, its algorithm such as type (Zhu et al. 1994):

$$r_{ij} = \frac{\sum_{k=1}^{m} x'''_{ik} \cdot x'''_{jk}}{\sqrt{\sum_{k=1}^{m} x'''^2_{ik}} \cdot \sqrt{\sum_{k=1}^{m} x'''^2_{jk}}} \quad \text{i} = 1, 2, 3, \ldots, \text{n}; \ \text{j} = 1, 2, 3, \ldots, \text{n}; \tag{136.1}$$

And get a fuzzy relations similar matrix $R = (r_{ij})_{n \times n}$

136.4.3 Dynamic Clustering Process (Kumar et al. 2004)

Fuzzy clustering analysis requires the establishment of fuzzy matrix is reflexive, symmetric and transitive, but according to (136.1) type of fuzzy matrix, is a fuzzy similarity matrix R, not necessarily is transitive, that R is not necessarily a fuzzy equivalence matrix. In order to classification, R also needs to be transformed into fuzzy equivalent matrix R^*. Therefore, need to use two leveling method [such as type (136.2)] on the fuzzy similar matrix R transformation, and the transitive closure of the t R (R), t (R) that is seeking a fuzzy equivalence matrix R^*, that is t(R) = R*.

$$R \to R^2 \to R^4 \to \cdots \to R^{2(k+1)} \to R^{2k} = t(R) = \left(r_{ij}\right)_{m \times m} \tag{136.2}$$

By (136.2) type get the fuzzy equivalent matrix t(R), t(R) in numerical arranged from big to small, λ is valued to the arrangement sequence, can form the dynamic clustering figure.

136.4.4 Determine the Optimal Class Number

In determining the classification number, often in dynamic clustering view, adjust the λ value in order to get the proper classification, without prior to accurately estimate the good samples should be divided into several categories. This method is often in the subjective desire to classification, and then to make λ, which leads to different people to the classification, will have the different results. Thus the proposed F-distribution to determine the optimal threshold value of λ, then according to the λ value in the view of dynamic cluster classification, finally get the optimal class number. The algorithm is as follows (Xie and Liu 2005; Guowei and Li 2010; Yingxue and Aixiang 2004):

Calculation of the original data matrix to overall sample center vector, in which:

$$\bar{x} = \left(\frac{1}{n}\sum_{i=1}^{n} x_{ik}\right) \quad (\mathrm{k} = 1, 2, 3, 4, 5) \tag{136.3}$$

Corresponding to the classification of λ set for r, sample number of class j is n_j, sample set of class j is $x_1^{(j)}, x_2^{(j)}, \cdots x_n^{(j)}$, cluster center vector of class j is $\overline{x}^{(j)} = \left(\overline{x}_1^{(j)}, \overline{x}_2^{(j)}, \cdots, \overline{x}_n^{(j)}\right)$

$$\overline{x}_k^{(j)} = \frac{1}{n_j}\sum_{1}^{n_j} x_{ik}^{(j)} \quad (\mathrm{k} = 1, 2, 3, 4, 5) \tag{136.4}$$

According to (136.3) and (136.4) the type of F-distribution, get (136.5)

$$F = \frac{\sum_{j=1}^{r} n_j \left\| \bar{x}^{(j)} - \bar{x} \right\|^2 \cdot (n - r)}{\sum_{j=1}^{r} \sum_{i=1}^{n_j} \left\| x_i^{(j)} - \bar{x}^{(j)} \right\|^2 \cdot (r - 1)} \tag{136.5}$$

Its molecular represents the distance between two classes, denominator represents the distance between the sample within-class. Therefore, the greater the F value that the distance between the classes and class is larger, classification is better.

If $F > F_\alpha(r - 1, n - r), (\alpha = 0.05)$, according to the statistical analysis of variance theory that the difference between the classes is remarkable, illustrating the classification more reasonable,If the value which satisfies the inequality $F > F_\alpha(r - 1, n - r)$ is more than one, can further study the size of $(F - F_\alpha)$, find a satisfactory F value from larger.

136.5 Multistage Fuzzy Comprehensive Evaluation

1. The establishment of evaluation set. Set evaluation V = $\{v_1, v_2, v_3, v_4, v_5\}$ = {good, better, generally, worse, bad} = {5,4,3,2,1}
2. Statistics, determine the single factor evaluation membership vector (Jingzhe and Wenrui 2002; Zhu 2004), and formed the membership degree matrix R

Membership degree in fuzzy comprehensive evaluation is the most important and basic concept. The so-called membership r_{ij}, refers to a plurality of evaluation main body to a certain evaluation object in the factor set to V assessment probability. Membership vector $R_i = (r_{i1}, r_{i2}, \cdots, r_{im}), i = 1, 2, \cdots, n, \sum_{j=1}^{7} r_{ij} = 1$, membership matrix R = $(R_1, R_2, \ldots, R_n)^T = (r_{ij})$

3. One stage fuzzy comprehensive evaluation

According to the original data to determine the solution of one stage membership fuzzy matrix R_{Bij} of each scheme, get: $B_i = W_{Bi} R_{ij}$

4. Two stage fuzzy comprehensive evaluation

Let one stage results constitute two stage single factor judgment matrix $R_A = [B_1\ B_2\ B_3\ B_4\ B_5]$, $A = W_A R_A$

5. Calculation of comprehensive score

$E = AV^T$

According to the comprehensive score height can determine various schemes, so as to select an optimal supplier.

136.6 Summary

Considering the fuzzy clustering algorithm can't distinguish between the data itself attribute imbalance, based on this algorithm with weighted fuzzy clustering and comprehensive evaluation method, the method of electronic commerce environment to select suppliers, this method can various factors taken into account, the objective reaction actual situation, the classification of the real problem can be more accurate.

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Chapter 137
Magazine Design Based on the Characteristics of Image Transmission in the Information Era

Kun-peng Jiang and Zhong-yang Li

Abstract In the information era, image transmission has become an indispensable methods for information dissemination. In magazine, image has the function of conveying information, attracting readers, adjusting reading, and communicating emotion. When designing, one should pay attention to the image arranging, creating sense of order in vision through the relationship between text and images, and also focusing on the borders of image usage.

Keywords The information age · Image · Communication · Magazine design

The information age is a new stage as human society develops to a certain stage. People get and transmit the achievements of civilization faster and more conveniently in the information age. In the last 20 years, with the popularization of video techniques, computer techniques and the Internet, image transmission bids farewell to its former secondary status. It also corroborates the saying “the view of image age around the world” which was put forward by the Germany philosopher Heidegger in 1930s. Heidegger believed that the world was grasped and understood as an image.

When designing magazines, text and images are the most basic medium for information communication; the text message is abstract, while the image information is more intuitive and representational which helps readers get information effectively. At present, due to the advent of the Internet and other multimedia, magazines are facing surviving crisis, so this article starts at the effect of the information age on image communication, and explores the role and layout of the images in magazine design.

K. Jiang (✉)
Institute of design and education of Capital Normal University, Beijing, China
e-mail: kunpengjiang@126.com

Z. Li
Capital Normal University, Beijing, China

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137.1 Images Communication in the Age of Information

Along with the rapid development of information in the 21st century, measures of transmitting and communicating have also changed a lot. In information age, the pace of life is going faster and faster, and a tremendous amount of information is around us every day, for instance information from outdoor media, mobile phones, Internet and so on. The increasing pace of life and the large amount of information around make people acquire information more directly and fast, so text-oriented publication cannot meet the rate of reading mode and habits of readers.

Due to the changes of information communication in the information age, we should cater for the readers, so image's role in magazine design is more and more important. Whether it is from a technical perspective, cultural ideas, or communication mode, now image s spread has already become consumer-oriented vision consumption. In addition, from the perspective of audience, they are browsing instead of reading, that is, readers tend to read selectively in the face of massive information now. Therefore, in order to cater for these readers, we must pay attention to disseminating information through image, instead of simply through text or text-oriented when designing magazines.

137.2 The Transmission Function of Images in Magazines

137.2.1 Conveying Information

Image is a "language" which is more acceptable and understandable, and it can speed up the transmitting of the message because it is simple and clear. Image is vivid and visual conception focusing on fun and diversified expressions. It can express things in depth and breadth, enhance the information conveyed (Li 2010), and give people an amazing impression.

Photographic images convey information, tell stories, and reflect the reality through visual elements of picture. The information in photographic images is more concentrative including background of time, scenes, characters or events etc. True-life photographic images are even more directively in showing the shape, material, texture, and other features of things. In the news-oriented column, images can give people the real and visual sense, and complement the inadequate point of the text. Image conveys news on one hand, and supports the content of the text on the other hand. Now, quite a lot of news and financial magazines not only use the image in numbers of columns, but also set up image-oriented columns with a bunch of images (assisted with text) to report news or to convey information. Both CBN and Fortune magazine have special image-oriented columns with photographic images serving to tell story and convey information to the readers, rather than decoration of the layout. For example, in Time magazine, the Light Box column in Briefing section of each issue uses spread image accounting for most of the layout just equipped with simple text. Images often contain a wealth of information, like places, mental outlook of person, surroundings and so on, and they guide readers to comprehend the richer contents by reading them. In addition, if designers can use the related images of locale and characters in news maker coverage, financial investigation etc., it will support the event, and be with excellent effect (Fig. 137.1).

137.2.2 Attracting Readers

In network era, paper medium is facing unprecedented impact. There is an eyeful of various magazines on the market, so if one wants a success in magazine marketing, one should pay attention to the image application, whose own aesthetic advantages will be more attractive to readers. Apart from disseminating information accurately, images in magazine also have a certain degree of artistic charm, such as good structures and good composition of light and shade relation etc., which can catch the reader's eye immediately, and then attract readers to read text or coverage of images.

In foreign magazines, due to the inherent competition of media, the overwhelming majority of press photos have very strong visual impact that usually use a more exaggerated way to bring visual impact directly. The image used in *Paris Competition* has some prominent characteristics. Firstly, image has the vast majority of characters—it often expresses by a single, several or a group of people even in the reports about the incident; Photo for characters from real life prefers to the realism and personal—putting character in the scene of casual, warm and closer to real-life (Chen and Zhou 2006). Secondly, the photo is mainly shot unintentionally, and with strong sense of dynamics, realism and live, providing readers with a strong visual impact. These characteristics of images used in *Paris Competition* have a strong impact on human visually so that readers are attracted.

Fig. 137.1 Briefing column of time

137.2.3 Adjusting Reading Rhythm

In most sections of magazines, text occupies quite a large space, and in order to maintain functionality of the text and the overall effect of layout it does not allow too many changes in forms or colors, so if there is no image inserted, the visual effect of layout will give people a sense of monotony, and boredom. Then, reading text for a long period of time can cause visual fatigue, so it will ease the visual fatigue of readers if you put a pleasant image in the right place.

While reading magazines, it is boring to simply read the text and it requires rational thinking, but images can be relatively sensible. Therefore, in the text-oriented article, images can ease readers' visual fatigue, and the two will complement each other.

137.2.4 Communicating Emotions

In artistic creation, imagination from literature can give us a lot of inspiration and creativity, and the image can create richer contents into works of literature, philosophy and sociology. Different images can reflect different cultural traditions, aesthetic concepts and the spirit of the time, etc., which can bring pleasure to readers.

Psychologists believe that the first impression of a person is vision. Feeling is the feedback from brain when the individual properties of things act on the human sensory organs. Consciousness is the reflection of brains to the objective that acts on sensory organ directly. At consciousness stage, audience will deepen the understanding of the images through associations based on their own life experiences, cultural background and aesthetic attitudes. People will express certain emotion during reading, such as satisfaction, happiness, etc. When the image brings a strong visual impact, or arouse some kind of mood, it will strike the heart of reader and trigger sympathy. When the significance created by images reacts on audience, touches the reader's mind, and the emotion of both will get in common. So images have a communication function, it can comfort the pursuing spirit, satisfy emotional demands, and please the body and soul of audience (Fig. 137.2).

137.3 The Images Application in Magazine Design

137.3.1 Order of Images in a Layout

No matter how many pages there are in a magazine, any person will get mental fatigue caused by visual fatigue no matter how fast or slow one's reading rate is. Therefore, when designing a image layout, we should take the advantage of

Fig. 137.2 Inside pages design of fortune

perceptual experience that we got from growing up. Readers feel the sense of order of layout with the potential perceptual experience, and at the same time, the sense of order reminds them of certain kind of visual experience or life experience. So, designers have to use the visual physiology phenomena and experiences to optimize the order of the image in layout, and give readers good sense of reading.

"Sense of order" is embodied by the permutation and combination of text, graphics, color and space, and it can be ordered by law, or changed in rule. United States Fortune magazine gives people a sense of coordination and harmony in separate pages, and the whole magazine, too. The entire magazine takes note of the coordination and harmony of the tone, size and placement of the image. By reasonable sorting and combination of images, balancing of the quantity and size of the images, allocating, choosing and tailoring image-specific, it forms a specific and reasonable relationship between cover and inside pages, pages and pages, contents and contents, contents and advertising. The number and the dimension of images on specific column of Fortune are decided by the importance and the orientation of columns, and the whole magazine forms rhythm and rhyme in people's reading process. Not only can the sense of order in pictures and text embody the orientation of production and the style, but also it gives people a relaxed feeling, which is the basis that Fortune establishes, and is also an aesthetic form differing from other magazines.

Image has its own internal logic. The internal logic of the image is formed by the relationship between its constituent elements, such as structures, lines, colors, things, characters, etc. Magazine designers need to mobilize the relationships between elements, and let elements echo from each other, and then the inherent logical relationship will be formed. The formation of internal logic is usually a spontaneous, natural process. As a single element, images' visual effect is totally different from what created by aesthetic treatment and creation of effective combinations, rational planning, appropriately clip, etc. The embodiment of the sense of order is primarily in the processing and mastery of the externally logical relationship created by a magazine's producing team under unified conception—this is the value of magazine producing team (Fig. 137.3).

Fig. 137.3 Inside pages design from *Fortune*

137.3.2 The Arrangement Order of Images in a Layout

When we design magazines we always meet different kinds of images and the effective classification is necessary, otherwise it will give the readers chaotic and disordered feelings and it is not beneficial to the transmission of information. According to different standards of classification, images in the magazines include various types so that we need to use different means of arrangement.

1. *Arranging the Images by their function and meaning*

We must have concrete objectives when we arrange every different image. Beautifying the page, emphasizing a certain type of effect and atmosphere, explaining a concept and a process in an article and attracting readers are among the most popular means of arranging images. The different utilizations of images determine the ways and orders of forming adopted by designers. The number of images for adorning and atmospheric emphasizing shouldn't be too big and the designers should arrange the positions of images properly so that they are in a subordinate status and will not affect the positions of text. Nevertheless, designers should know how to properly arrange those images so that to transmit certain information. For example, a group of images which are taken for illustrating a certain process should be dealt with jointly. Only through sufficient consideration of the order and the size of images can designers make the page flowing and in good order. In addition, images which can directly and powerfully transmit information should be made as large as possible in news reports (Fig. 137.4).

2. *Arranging the images by hue*

The images have obvious tendency in color; therefore, we should arrange the images according to their hue so that we can keep the balance of a page. The images in the same page should be within the range of hue, which can avoid the vision disorder caused by the chaos of color.

Fig. 137.4 Inside pages design from *Fortune*

3. *Arranging the images by their structures*

The images will present different structures according to the variations of the shooting angles and distances, such as the close focus presenting the features and distant focus presenting full shot. It will give people the feelings of order when the images with similar structures are put together, while it will present inconsistency and increase difficulty in reading when the images with different structures are put together.

137.3.3 The Using Boundaries of Images Arrangement

In the process of editing and arranging images, designers should bear in mind appropriate measures (e.g. size, shape, color, etc.). The size of images should be appropriate so as to fit the size and layout of the magazine. Moreover, there shouldn't be too much change in the shape of images. Colors of images should also be steady and implicit without the phenomena of jumping from one hue to another hue abruptly. It is not appropriate to use visual elements excessively even though the image vision is important. The excessive designing and the abuse of designing elements will cause the visual disorder and let the design step to the opposite side of visual appreciation, which will interfere the process of unfolding of the people's version, and make people feel that the design is of nothing, and finally completely fall into the trap of the pure Design.

1. *Images should be properly located in a certain layout*. In order to attract readers' attention, location of essential images can be adjusted in the order of their importance. Firstly, designers can locate the images on the visual center of the magazine. For example, it will be more appealing to readers if we put images on the upper-left corner in an ordinary book. In addition, we can also isolate one image from other images of the same kind for emphasizing.

2. *Change of the shapes of images*. In order to make the page more active, designers can adjust the shapes of images and add some dynamic elements in the normal layout. In all, designers should use images properly so as to finally achieve the effect of transmitting information in a convenient and fast way.

137.4 Summary

In brief, in the information era, both the spread of information and the change in its ways are extremely rapid. Moreover, the spread of images in magazines are playing an increasingly important role. Images can be used to transmit information, to adjust reading and to communicate. Therefore, we must use these characteristics of images to the greatest extent in order to pass on information and improve the visual image of magazines regarding finance and economics.

In the detailed arrangement designing, taking advantage of reading habits of readers and principles of style designing makes the visual image of magazines regarding finance and economics more in order so that the readers can accept information in a more direct and accurate way.

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Chapter 138
Research on Application Integration Solutions of Enterprise Information System Based on Web Services

Yan-hui Hou, Min Hao, Wei Wang, Hong-tao Yue and Yong-jun Ding

Abstract Enterprise application integration is an effective solution to realize the integration among enterprise information systems. In this study, the differences between traditional and web services-based enterprise application integration scheme were analyzed. On the basis of web services technology, main framework of EAI (both inside of enterprise and business to business) based on web service was established. Furthermore, EAI framework based on J2EE platform was constructed. In the end, a case study of EAI based on J2EE platform between ERP and CRM was presented which shows the feasibility of EAI scheme discussed in this study.

Keywords Enterprise application integration · Enterprise information system · Web services · Interface

Y. Hou (✉) · M. Hao
Department of Economic and Management, ShanDong University of Science and Technology, Qingdao, China
e-mail: Coolhyh@126.com

M. Hao
e-mail: candyca4145@sina.com

W. Wang
The Principal's Office, ShanDong University of Science and Technology, Qingdao, China
e-mail: W1969@sdust.edu.cn

H. Yue
Mechanical and Electrical Team, Xinglongzhuang Coal Mine, Jining, China
e-mail: hongtaoyue@sina.com

Y. Ding
Electrical and Mechanical Division, Wanfu Coal Mine, Heze, China
e-mail: dyjjdd@126.com

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138.1 Introduction

In the increasing competitive market, most enterprises introduce various Enterprise Information System (EIS), such as Enterprise Resource Planning (ERP), Customer Relationship Management (CRM) and Supply Chain Management (SCM) etc. However, due to the EIS are self-contained independent systems, in other words, each system has its own independent applications, processes and data, that results in the partition of the application of EIS, generates one and one information island, to some extent, which cause unresponsive EIS, costs increasing and benefits decreasing (Madhusudan 2004). All kinds of EAI solutions are presented for a better solution of EIS integration and sharing of information to eliminate Information Island. The ultimate goal is, on condition that the existing applications do not change too much as far as possible, to integrate all kinds of EIS seamlessly and realize data sharing and integration of business processes by the combination of hardware, software, standards and business process (Zhou 2005).

138.2 Program Analysis of EAI

138.2.1 Traditional EAI Program

The traditional EAI adopts tightly coupled method, that is, if completing integration between System A and System B, the System A needs to write an integrated adapter for System B, meanwhile, the System B needs to write an integrated adapter for System A. When carrying on the integration among multiple application systems, each system needs to write an integrated adapter for other systems. This method has brought a heavy burden on application integration staff within the enterprise. In addition, traditional EAI depends on the specifically integrated application providers, and solutions of different providers are very difficult to be exchanged. There are several typical of such integrated technologies as CORBA of ORG, Microsoft's DCOM, and RMI of SUN (Liu 2004; Mo 2004).

138.2.2 The EAI Solution Based on Web Services

Web Services, as a distributed computing technology, show variety of application services by using standard XML protocols and information formats in the Internet/Intranet. Packaged into web services, these applications use XML, SOAP, WSDL, UDDI and other technology and take their function or method as web services interface to display. These applications are all you can call the Web service for other ones that call them, regardless of their development language and platform (Yuan et al. 2004).

Compared with traditional EAI solutions, the advantages of EAI based on web services embody in the following three aspects.

1. *Uniform interface*

By Web Services package application system interface on a unified form to make the core business dispense with supply of various interfaces butt integration of the two sides, thus avoiding redundancy of resources deployment.

2. *Integration mechanisms*

Web Services technology provides a loosely coupled mechanism for both sides of integration. Any demand side who just comprehends a general interface (Web Services), can integrate and call the existing web services on the internet, regardless of such details as internal implementation mechanisms of web services, operating platforms and programming languages etc. At the same time, even in the future operation, as Web Services change the interface or functional, integrated caller can find and adapt to such changes timely through the Web Services Description Language (WSDL).

3. *Information discovery*

The UDDI registry of service-oriented architecture stores information and interaction parameters of all business entity in the way of web services. Companies can find and integrate new business partners and provide the new kind of web services in the spontaneously unattended way (Ohannession and Perjons 2001; Ferguson 2001).

138.3 Main Framework of EAI Based on Web Services

For the defects of existing EAI solutions, this paper designs main framework of EAI based on web services (shown in Fig. 138.1) by the researches of basic technology and enterprise application environments.

138.3.1 Application Integration Based on Web Services Inside Enterprise

As Fig. 138.1, the left EAI and right one are called Application to Application (A2A) integration, which is the basis of enterprise application integration (Mo 2004). The specific method is, through the establishment of an internal web services platform (web application server), to carry on web services transformation of the various systems left within the enterprise, namely use business logic of

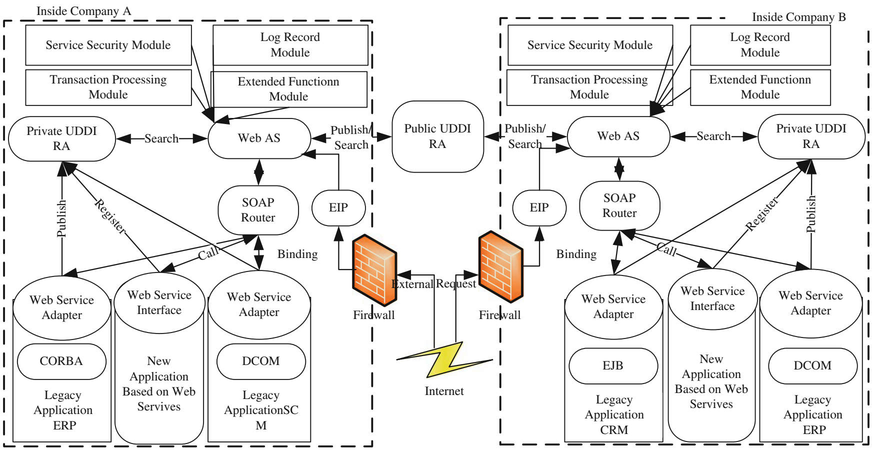

Fig. 138.1 Main framework of EAI based on web services

legacy systems to establish homologous web service adapter, and publish it to the internal UDDI (The web application newly developed are registered to the UDDI through the web service interface). Other systems can call the relevant web service interface before using the related functions (Meehan 2002). Therefore, the internally original disperse system developed by different platforms, languages, and tools, can be reapplied through the model of web services that not only retains the technology investment existing of business and saves the cost of the new system, but also improves the implementation efficiency of the of new applications, and provides system with an open platform for further expansion. On the other hand, the application integration based web service within the enterprise provides a good foundation for the application integration across enterprise. Through the web service server (including the SOAP router) calling/binding web service interface, it can re-package existing enterprise applications and make up the web services with complex function, and publish uniform interface to Internet (Meehan 2001; Dobb's 2003).

138.3.2 Application Integration Based on Web Services Business to Business

Application integration between Company A and Company B is called Business to Business (B2B) integration. Business logic outside enterprises is encapsulated by web services using a unified description of WSDL, and registers in the UDDI center of third-party organizations. Thus, the integration of B2B transforms into the butt of Web service. Developers can search UDDI registry of private enterprises by the public UDDI registry and accesses to the description document of other Web services WSDL, then automatically loads description documents of WSDL into their own platform by Platform tools, and generates the corresponding interface. Developers can quickly understand the data structures of interactive application by XML Schema tools, then just introduces the calling interface and data structure generated by the platform tool into their own applications and uses SOAP to interact with other web services technology, thereby, completes application integration of business to business (Houlding and Dobb's 2003).

138.4 Researches of EAI Framework Based on J2EE Platform

138.4.1 Integrated Implementation Framework

On J2EE Platform, implementation framework of EAI based on web services (shown in Fig. 138.2) includes three parts those are client, middle layer and background system (Yuan et al. 2004). Client allows customers to find and call web services in different ways (web browser or enterprise application programs),

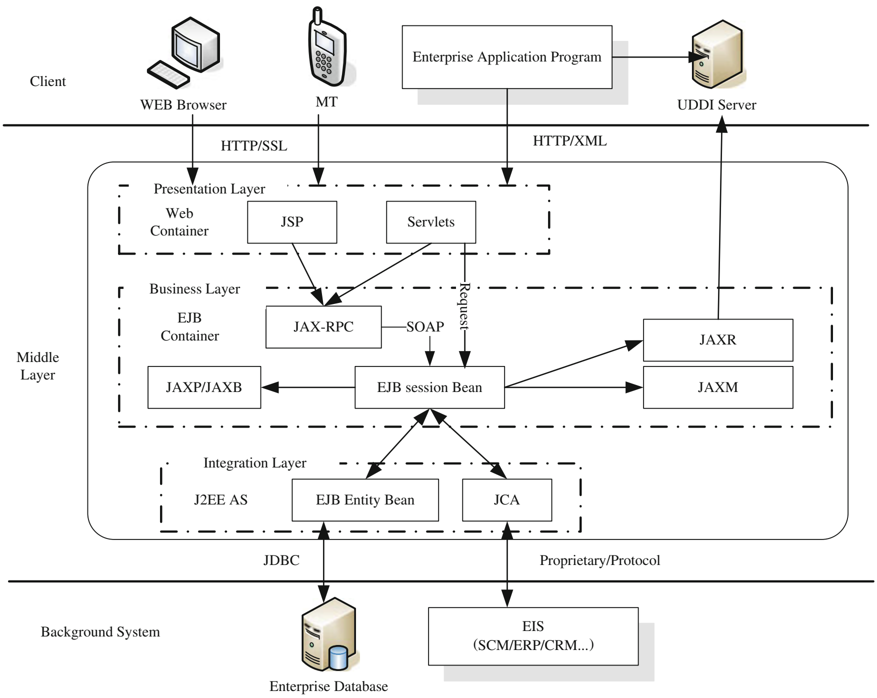

Fig. 138.2 Implementation framework of EAI on the J2EE platform Integrated Implementation process

so as to achieve the client's connection. The middle layer is responsible for developing, deploying and publishing web services, and connects client with background system. It also can be divided into presentation layer, business layer and the integration layer. Presentation layer is comprised of the web components (JSP, Servlets etc.) and responsible for handling request/response of HTTP, XML and other, session management and calling of the business layer components, etc. Business layer uses EJB Session Bean to achieve the logic functions of company's core business, meanwhile transforms the related business logic into web services, and published it to the UDDI server; integration layer is responsible for disposing communication and connections between business logic and background systems, such as using EJB Entity Bean to access corporate databases and using J2EE Connector Architecture (J2EE Connector Architecture, JCA) to reach integrations between business logic and enterprise information systems, etc. Background systems afford supporting environment for enterprise application integration, including corporate databases and enterprise information systems (Gutierrez-Garcia et al. 2012; Jarrah and Zeigler 2012).

138.4.2 Integrated Implementation Process

Implementation process of EAI based on web services can be build on J2EE platform through Rational Rose of Visually Unified Modeling Language (UML) Provided by Company Rational. That is, the provider of web services publishes under-integrated services to the UDDI registry, and then web services requesters find and call these services to realize enterprise application integration (Ohannession and Perjons 2001).

The Sequence Diagram describes the process of provider developing, deploying and publishing web services on the J2EE platform, including the web services definitions, implementation, deployment and dissemination.

The steps are as follows:

1. *Definition of web services*

Web services provider chooses EJB Session Bean published, and generates the WSDL description so as to establish the mapping of WSDL to EJB; then to standardize defines of the service endpoint by the JAX-RPC and define the available methods service endpoints provide.

2. *Implementation of web services*

Choose a specific service endpoint and implement all the business logic methods the endpoint has defined, and then generate deployment description which defines the information of service name, service target namespace, the required package and class name, etc.

3. *Deployment of web services*

Establish a deployment package, and position web services into the EJB container of J2EE component. This deployment is made up of description of web services, standards description of EJB components and characteristics description of web services operation.

4. *Publish of web services*

Use JAXR to publish web services to UDDI registry after it being positioned into the J2EE container.

Since then, information about integrated services that web services providers can provide, has been published to UDDI center, web services requester can view the list of services and call their services needed through accessing the UDDI center (Tong et al. 2011; Serhani et al. 2011; Wang et al. 2011).

138.5 Case Studies

ERP, as a kind of universal management platform of enterprise information, implements integrated management of the enterprise's financial, material, product design, manufacturing and human resources; while CRM to enterprise customer as the center, executes the collaboration of sales, service and marketing outside enterprise. Enterprises must complete application integration of ERP and CRM before achieving the goal of product design and manufacturing driven by customer and market's demand.

Shown in Fig. 138.3, in order to achieve the information integration between the product design module of ERP and product demand module of CRM, package

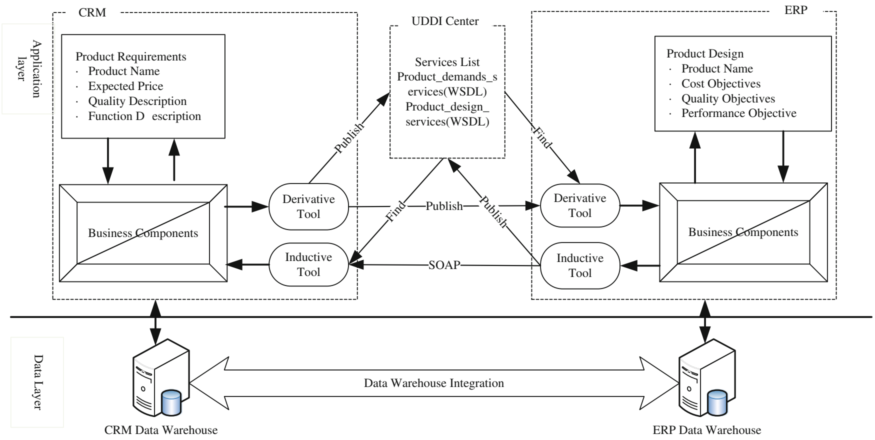

Fig. 138.3 Integration based on web service of ERP and CRM

business components of CRM related to product demand analysis into the web services through the derivative tool of secondary development interface, and publish it to enterprise UDDI registry. When product design module of ERP needs to call the product information demand analysis of CRM, it can use inductive tool of secondary development interface to search for this kind of service in enterprise UDDI registry and get the WSDL binding information of the Web Services, afterwards the inductive tool of ERP can communicate with derivative tool of CRM by SOAP, and product demand information is transmitted into the product design module, so as to complete data transfer between the two. On the contrary, the principle is as mentioned above.

138.6 Conclusions

EAI based on web services realizes real platform independence and language independence, so that it can easily integrate various enterprise information systems together seamlessly. It is beneficial to the cross-platform interoperability establishment of information sharing and data exchange that the loose joint and dynamic integration use web services.

On J2EE platform, EAI based on web services this paper proposed, not only satisfies the needs of EAI, but also can minimize the complexity of EAI and improve the flexibility of whole system. In addition, the development of EAI adopts some technologies of JSP, Servlets, EJB and data exchange supporting for XML, which optimizes the system function and minimizes inter-dependence of technology within system.

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Chapter 139
The Design and Application of the Framework of Coal Mine Comprehensive Information System Based on 3DGIS

Bin Wen, Rui-xin Zhang, Chong-de Lin, Ming-liang Wang and Quan-guang Ba

Abstract In this article, we firstly analyzed the development direction and trends of the information application of coal mine enterprise, and introduced the status of using 3DGIS into the mine information development. Secondly, we gave the principle of the coal mine comprehensive information system development, and put forward a framework of coal mine comprehensive information system platform based on this principle. This platform generates the 3D topography, mine tunnel stereoscopic drawing and excavated stereoscopic drawing based on the data of the geological survey and engineering, and shows the production information, real-time dynamic monitoring information by 3D on the mine excavated stereoscopic drawing, and the overall real perspective of the mine, including the ground and underground, will be spread out. Finally, we tried a pilot to develop and apply an information system platform based on this platform framework.

Keywords 3DGIS · Coal mine comprehensive informationization · System integration · System framework

B. Wen (✉) · R. Zhang
School of Mechanical Electric and Information Engineering, China University of Mining and Technology, Beijing, China
e-mail: wenbin-315@163.com

B. Wen
School of Information Science and Technology, Yunnan Normal University, Kunming, China

C. Lin
Beijing Sanwijisi Engineering Software Technology Co. Ltd, Beijing, China

M. Wang · Q. Ba
Faculty of Resources and Safety Engineering, China University of Mining & Technology, Beijing, China

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139.1 Introduction

With the rapid development of the computer and network technology, the coal mine safety monitoring technology is constantly popularized and applied. The coal mine enterprise is gradually developing on the concentrated management schema by collectivization. So, to the coal mine production and safety monitor, we not only think monitor some side safety factor of the coal mine production, but also take the coal mine production as a whole to think and form the comprehensive safety monitor system (Lin 2010). The sub-systems of the safety monitor system are all separated, and every sub-system forms a system, then the system has the difficult maintenance, the poor reliability, the low sharing and utilization of the information resource, and it is difficult to be unified management (Qiao 2010; Wang et al. 2010). So, the high integration of the coal mine safety and production comprehensive information, 3D visualization of the safety production management and dispatching, and the digital coal mine development are the information development trends of the coal mine enterprise.

In the information management of the coal mine enterprise, the enterprise not only need to set up the digital coal mine, but also need to realize the 3D visual coal mine platform, which highly integrated the geological gauge information, the project information, the production information, the safety monitoring information, the mine worker positioning information, the comprehensive automation monitoring information and other office system information (Peng-fei and Jun 2009; Liang et al. 2010; Jun 2010; Han and Tian 2009). The relevant data, diagram and chart which are needed are indirectly queried by the visual and real dynamic 3D figure. So, the development trends of the coal mine informationization are digital, informationization and 3D visualization.

In this paper, according to the software, hardware and network of the coal mine enterprise, we designed the logical structure and system framework of the unified integrated software platform. This logical structure and system framework generates the 3D topography, mine tunnel stereoscopic drawing and excavated stereoscopic drawing based on the data of the geological survey and engineering. The data and information about the monitoring and production are showed by integration on the 3D stereoscopic drawing. We also tried a pilot to develop a system and put it to application according to this logical structure and system framework.

139.2 The Status of 3DGIS Research and Application

3DGIS technology can seamlessly integrate spatial data and its related attributes information, visualize graphs and images, and comprehensively analyze multi-source and heterogeneous data (Fan et al. 2010). At present, there are many commercial 3DGIS software firms which are already put forward the 3DGIS platform, such as Mapinfo and ArcGIS, etc. But these platforms mainly are used to the traditional survey domain (Wang 2010). The technology of synthesizing, integrating and showing of the 3D data and information of safety information is popular to focus on by the national coal mine research institutes, and this technology is rapidly developed (Yu 2011; Zhi-fan 2007). It is very difficult to develop the comprehensive platform of coal mine safety production data based on 3DGIS, and it need the developed members have the good mine profession knowledge and the rich experience of developing the enterprise software to integrate their data and information (Fu et al. 2003). The main member of all mine enterprise software development have the mine special background, and they are good at develop the profession software about the mine enterprise interior business flow and model, then their technology ability are not enough to integrate the safety information into an unified data comprehensive platform based on 3DGIS. The integrated software based on 3D lags the market needs.

139.3 The Principle of Developing the Coal Mine Comprehensive Information System Platform

The principles of developing the coal mine comprehensive information system platform are as follows (Gan et al. 2003; Sun et al. 2009).

139.3.1 Entirety

The coal mine informationization construction is the information system platform development, and it is not the sub-system development or the profession system development. The system platform development needs the platform have the more entire information and function, this avoid to cause new information islet. The system platform not only contents the safety and production management of the building mine and production mine, but also the coal mine manage itself.

139.3.2 Advancement

On the premise of contenting the entirety, the whole technology should be advanced in the internal, and it will not lag in 5–10 years. Advancement not only presents improving the mine safety production management and the enterprise production, but also expresses the enterprise management level and the enterprise image.

139.3.3 Maturity

The whole system platform has the mature function and technology, and the successful using example. This ensures the stability and reliability of running and using the system platform.

139.3.4 Extension

As a system platform, its extension ability shows whether it has the long using life or not. The system platform can join up the new system and make it perfected constantly according to the enterprise development demand.

139.4 The Design of the Logical Structure and System Framework of the Coal Mine Comprehensive System Platform

139.4.1 Logical Structure of Platform

The mine geological survey information, engineering information, production information, safety information, equipment working status information will be integrated into the comprehensive system platform. So, the centralized storage application, distributed management, unified data and sharing by authority should be as the goal of the system platform, and the hierarchical logical design is adopted, the system platform is divided three layer logic structures from top to bottom, that is the data layer, the business layer and the user layer. It shows in Fig. 139.1.

The data layer mainly includes the data organization, the data storage and the data management from many systems. The data to organize, store and manage includes the geological survey data, the production information, the safety monitoring information, the mineworker positioning information, the report forms, the tube bundle monitoring information and the video monitoring data, etc.

The business layer mainly processes the business logic and data. The business logic and data to process includes the geological data processing, the production data processing, the real monitoring data processing, the report form data analyzing and processing, the tube bundle monitoring data processing and the alarm data processing.

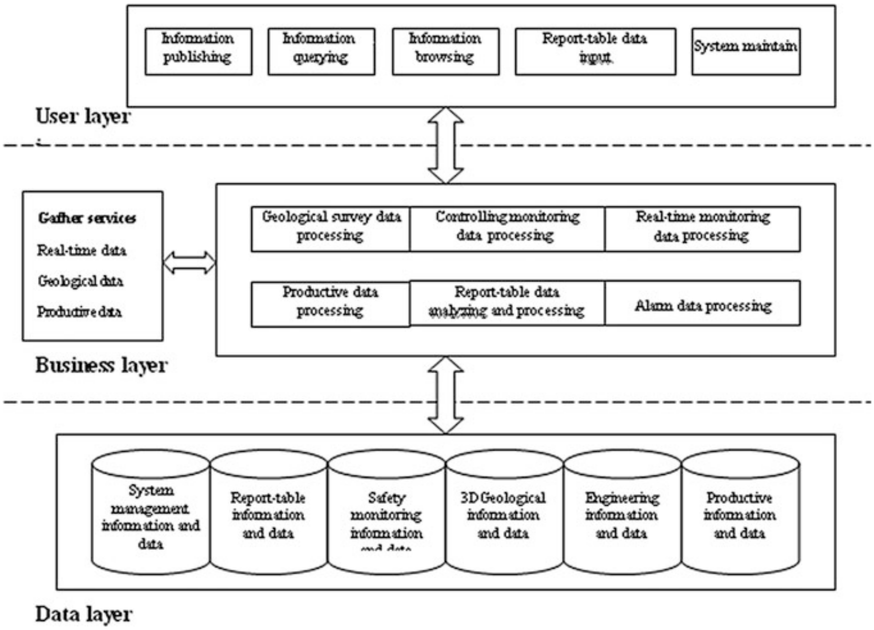

Fig. 139.1 The logical structure of system

The application layer mainly expresses the information result. The expressing information result includes the information publishing, the information querying, the information browsing, the report form data inputting and the system maintaining.

The data layer, business layer, the application layer join and interrelate each other in the system.

139.4.2 The System Framework

The geological information, information, production information, safety information, equipment running status information will be queried and showed in the system. The 3D visual technology can realize the visual showing, but the 3D showing needs a certain software to support. To the users, the developed system should be flexible and not be restricted by the platform. So, the whole system framework is based on the B/S and C/S model, and the users can feel the information management, the 2D and 3D image management and the information sharing in the B/S model. The system framework shows in Fig. 139.2.

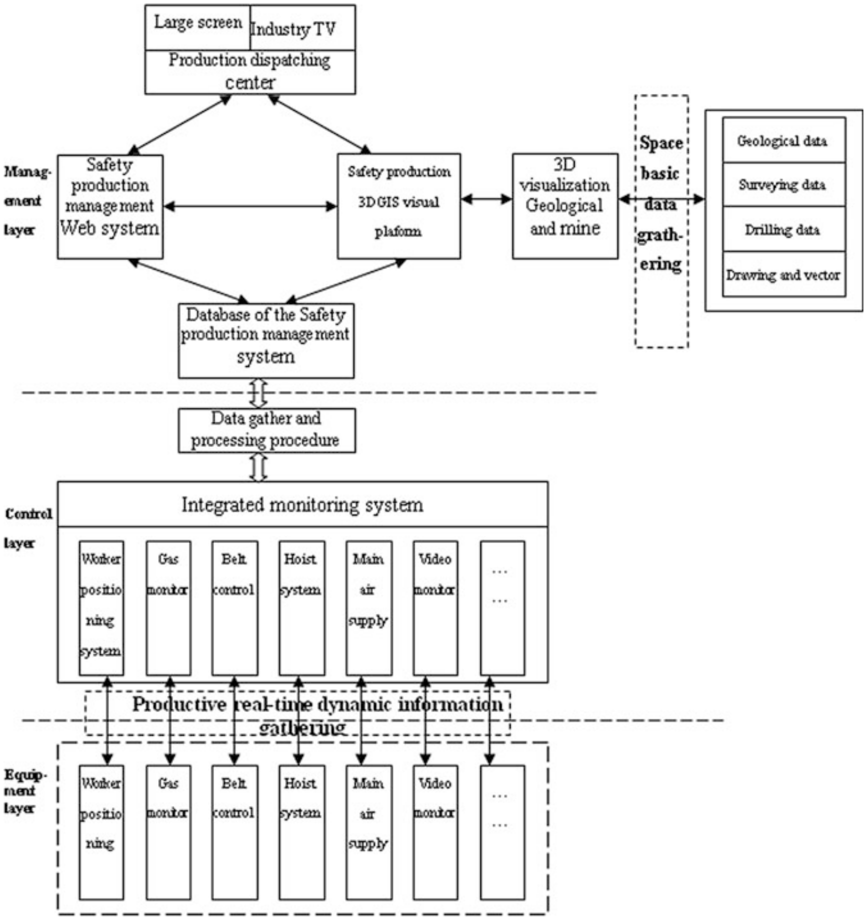

Fig. 139.2 The system framework

The system framework includes the equipment layer, the controlling layer and the management layer.

The equipment layer mainly monitors the real-time and dynamic information of the mine by the sensors. Including the mine worker positioning information monitoring, the gas information monitoring, the belt controlling information monitoring, the hoisting system information monitoring, the main air exhausting machine information monitoring and the video controlling information monitoring.

The controlling layer mainly processes the real-time and dynamic information which is gathered by the comprehensively controlling system, manages and controls the equipments and workers. Including the person location system, the gas monitoring system, the belt controlling system, the hoisting system, the main air exhausting system, the video monitoring system process the monitoring data by gathering, manage and control the relevant equipment and workers.

The management layer mainly realizes the comprehensive querying the geological survey information, engineering information, production information, safety information, equipment working status information by the user-computer interface of the 3D visual system platform and the web production management system. The management layer supplies the advanced information supported platform, including showing on the dispatching screen and the industry TV, for the safety and production management of mine.

Where, the 3D visual system firstly automatic generates the 3D geological topography and the 3D stereoscopic diagram of the mine engineering based on the geological data and the engineering data. Secondly, it reads the real-time data from the safety monitoring system by the data gathering and processing procedure, and stores the data into the local database of the safety and production management system after the real-time data processing. Next, the 3D visual system shows the production information and the real-time dynamic monitoring information by 3D in the mine excavating stereoscopic diagram. The production information and the real-time dynamic monitoring information include the 3D distribution of the harmful gas, the 3D distribution of the workers, the 3D distribution and working status of the safety and production equipments, the video monitoring images of the underground and ground of the mine. The real overall perspective of the underground and ground of the mine will be showed.

The Web safety and production management system shows the production information and the real-time dynamic monitoring information in the mine excavating stereoscopic diagram. The production information and the real-time dynamic monitoring information include the distribution of the harmful gas, the distribution of the workers, the distribution and working status of the safety and production equipments, the video monitoring images of the underground and ground of the mine.

139.5 Pilot of Development and Application

Based on the above logical structure and system framework, we tried a pilot to develop an information platfom and apply in the Muchenjian coal mine of Beijing Haohua incorporation. The platform development project is started to survey and research in December 2010, and the system is worked in September, 2011. The system platform is working well now. The platform is based on the geological data and the engineering data of Muchenjian coal mine, and generates the 3D geological topography and the 3D stereoscopic diagram of the mine engineering by the 3D visual platform. The platform integrated the mine workers positioning

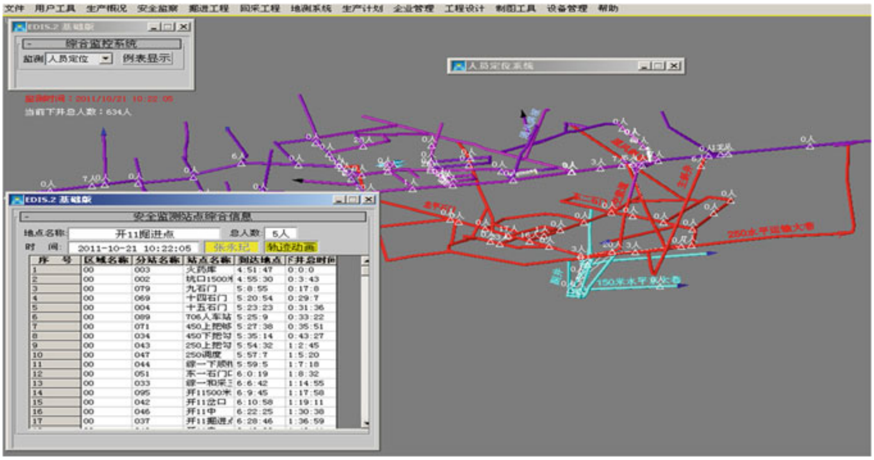

Fig. 139.3 Integration of the mine worker positioning system in the 3D stereoscopic diagram

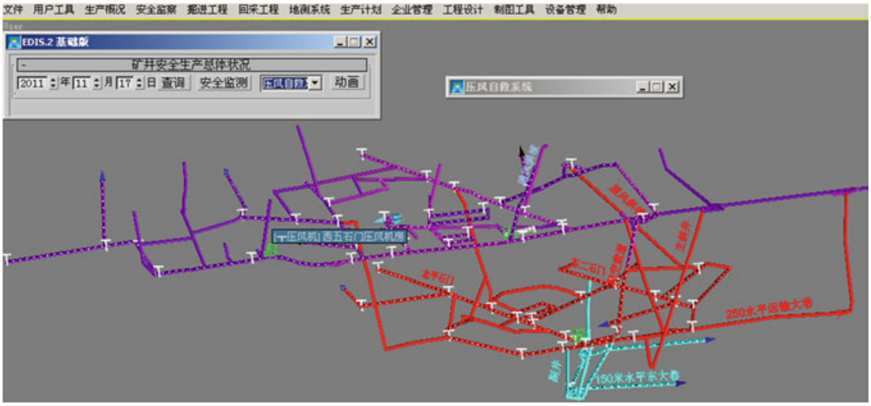

Fig. 139.4 Integration of the air supplying system in the 3D stereoscopic diagram

system, the air supplying system and the water supplying system. The platform shows the mine workers positioning information, the air supplying information, and the water supplying information by 3D. The effect of the mine workers positioning information, the air supplying information and the water supplying information showed in the 3D excavating diagram is in the Figs. 139.3, 139.4, and 139.5 respectively. The web safety and productive management system is showed in Fig. 139.6.

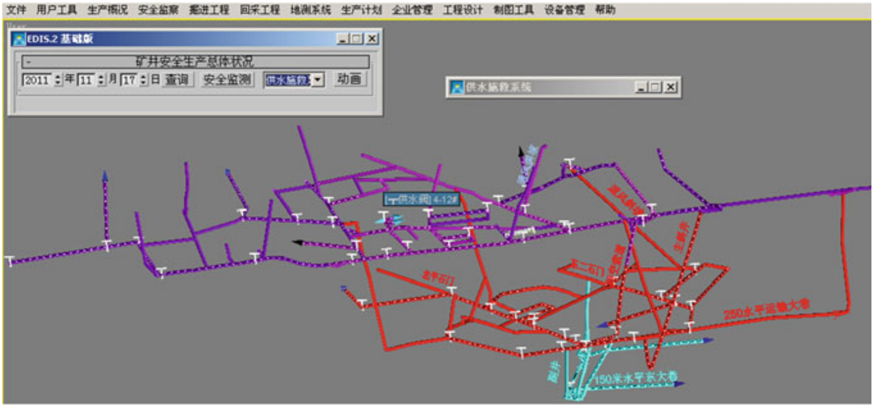

Fig. 139.5 Integration of the water supplying system in the 3D stereoscopic diagram

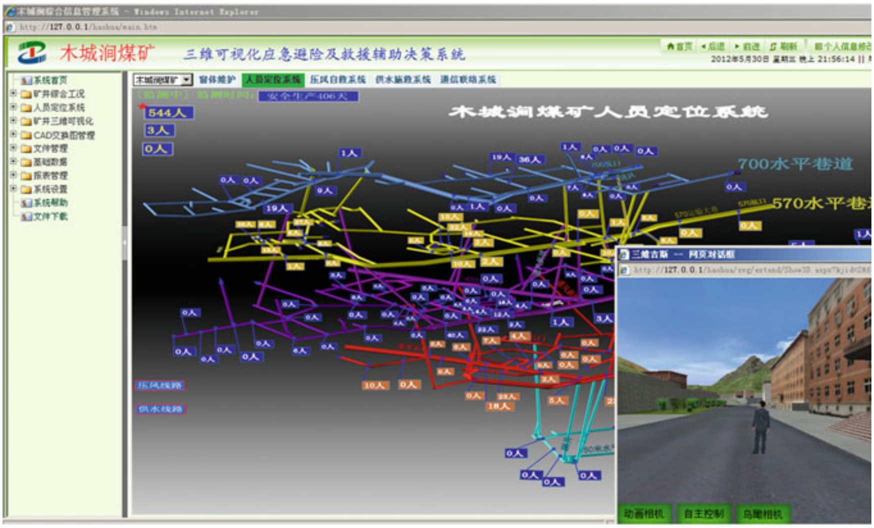

Fig. 139.6 The safety and productive management web system

139.6 Conclusion

In this article, according to the software, hardware and network of the coal mine enterprise, we designed a logical structure and a system framework of the coal mine integrated information software platform. We also tried a pilot to develop a system platform and put it to application by the logical structure and system framework. The integrated information software platform supplies the advanced information supporting to the safety and production management of the coal mine.

In the future, the gas monitoring system, the controlling monitoring system and the video monitoring system are integrated and showed in this platform is our research content.

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Chapter 140
Analysis of Problems on Network Education Resources Construction

Yong Zhang

Abstract Informatization tide sweeps across the whole world, the tentacles of network extend to every corner of the world. The globalization of computer network provides education a new resource. Network education has become a new model of educational technology in its development, which no doubt poses a new challenge to the development of the new century education. This article analyzes the concept, form and method of network education resources construction, points out the development trend of network education resources construction, which makes a beneficial discussion to promote the application of network education.

Keywords Network education · Library · Resource sharing · Excellent course · Information resources

140.1 The Characteristics of Network Education Determine the Necessity to Improve Network Education Resources

At the beginning of new century, network technical education is increasingly becoming the mainstream of the development of educational technology, and currently is in the initial explorative stage of network technical education application. The network as a new communicating technology and resource is introduced into modern education, which may have a great impact on former education environment, education idea and education pattern, but meanwhile will promote the reform of the traditional education mode for further deepening.

Y. Zhang (✉)
Huanghe Science and Technology College, Zhengzhou, China
e-mail: y_z1@hotmail.com

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Traditional students study passively just around the teacher, and teaching of teacher is inseparable from traditional tools, like blackboard and chalk. The application of Internet in education will make a great impact on traditional education mode and break the traditional mode. It mainly has the following characteristics:

140.1.1 Interaction

Interaction; the Internet as a powerful interactive media, possesses a variety of technologies to support network communication. The communication way is diverse, so teachers and students can choose different interactive mode according to needs.

140.1.2 Compatibility

It can also collect learning resources, such as text, graph, audio, video, animation and other media, in network education together according to the needs of teaching, with hypertext presentation, bearing characteristic of systematicness and flexibility.

140.1.3 Scale

Having a wealth of information resources is one of the largest charms of network. And network information resources are diverse, which involve all fields of social life and various disciplines. Network information resources can be shared, and no one is the master of information; as for every learner in network terminal, they are all equal in the face of the information. With a large number of sharable information resources, it is just one of main reasons that network has a strong developmental momentum in education. It has characteristics of scale and interaction, including how to communicate more efficiently between teachers and students and how to bring more and good learning resources into the internet in efficient way allowing more people to see (Zhao 2000).

As a result, network education can not be separated from relevant text, audio, video, animation and other media resources. Expanding and improving network education resources are an important task before educator.

140.2 How to Establish and Improve the Network Education Information Resources

The man–machine interaction design of computer multimedia teaching software can be divided into three levels, including operational interaction, information interaction and intelligent interaction. Multimedia teaching software is a kind of computer teaching program designed by teaching goal, presenting specific teaching content and reflecting certain teaching strategy and is a teaching media which can be used to store, transmit and process teaching information, and is available for students to operate interactively and can assess student's learning.

In recent years, with the popularity of multimedia teaching software, all kinds of multimedia teaching software of various professional fields is gradually increasing, among which there are a lot of excellent teaching software. If we can use the advantage of network to build sharing platform of multimedia teaching software under the premise of protecting author's copyright, it will be conducive to realize the value of high-quality education resources to a greater extent (Yuan et al. 2006).

It is a good way to construct education resource web portals (GEM). At present, many countries have successively established educational resource web portal, such as, American education resources website (http://www.thegateway.org/). This website, without placing any education resource noumenon, is primarily a data base recording the description of educational resource metadata with a search engine, but linking all kinds of educational resources together and providing numerous of educational resources information to American even global teachers, parents and students; they are distinguished from the common search engine, its working principle and website construction mechanism is very special. The British also has built a national education portal (NGFL). The author believes that establishing a unified university education resources portal in the future is an inevitable route of the development of our education resources. Therefore, it has great referential significance for us to study education resource portals of these countries (Li et al. 2001).

140.2.1 Integrating High-Quality Network Educational Resources and Constructing Education Resources Web Portals

The man–machine interaction design of computer multimedia teaching software can be divided into three levels, including operational interaction, information interaction and intelligent interaction. Multimedia teaching software is a kind of computer teaching program designed by teaching goal, presenting specific teaching content and reflecting certain teaching strategy and is a teaching media which can be used to store, transmit and process teaching information, and is available for students to operate interactively and can assess student's learning.

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140.2.2 Establishing Network Resource Sharing System of Modern Digital Virtual Library

Modern network education, as a supplement of traditional education mode, provides traditional education rich and colorful auxiliary teaching methods. In the network environment, make use of rich literature resources in traditional library, use modern electronic information technology to compress information resources and transform them into digital information, then deliver to readers with convenient, efficient means. It can also organically combine with university network teaching formed gradually, improve education quality, promote the development of university education business, especially the digital virtual library's development, and highlight library's network education advantages (Wu 2003).

The advantages of digital virtual library:

1. The digital virtual libraries can provide network education's electronic resource; reduce the storage space of network education information.
2. Use network and information technology to provide readers with remote search, browse, or file download and transmission function.
3. Realize real-time information service; users can not subject to restriction of time and space to access the network education resources.

4. It can extends readers, that is to say, serve readers across region even country. According to incomplete statistics, more than 500 universities in our country have set up their own campus network linking with the Chinese Education and Research Network. This huge modern distance education network has put our university library in network environment and can give full play to library's learning advantage.

On July 1, 2008, the National Library of China and the national cultural information resources management center of the Ministry of Culture held cooperative signing ceremony at the Wenjin Hall of National Library. The National Library of China and the national cultural information resources management center signed a cooperative agreement, which dignified that rich digital cultural resources of the National Digital Library would serve the public through the national cultural information resources sharing project network system. It plays an active role in extending the service approach of national digital library, enriching resources of culture and education project, promoting the service capacity of public culture and education and boosting the development and prosperity of culture and education (Jiang 2006).

"National Library Project (phase II) and National Digital Library Project" built by the National Library is key cultural construction project started up during "fifteen plan" of our country. The National Digital Library Project is an important part in our information construction, which plays a leading role in the construction of our digital library. Since the project is started, based on the principle of "making construction as giving service", continue to increase the category and amount of digital resources, expand the scope of service, develop network service projects in order to provide simple and fast, abundant and high-quality information and knowledge service for the public. The cultural resources sharing project organized and implemented by the Ministry of Culture and Ministry of Finance jointly is the foundational project that using modern information technology strengthens the construction of public cultural service system. Since the project has been formally implemented in 2002, more than 570,000 different-level centers and basic service stations has been constructed, which has initially formed different-level public library, township comprehensive culture station, village culture activity room as implementing body, covering service network of the whole country, with 65 TB of digital resources (Li and Lei 2005). At present, the number of radiation people by sharing project has reached billion. Through the project platform, excellent cultural information resources are transferred to every corner continuously by internet.

The National Library has meticulously organized a total of 2.62 TB of digital resources for this cooperation throwing in the service website of the national cultural information resources sharing project in July 2008 and providing free service for the public via the Internet, LAN, e-government extranet, CD, satellite and other channels. This time, the resources provided mainly includes: 50,000 categories and 3.3 million volumes of e-book, 190,000 types and with 380,000 volumes of e-book remote account access; 1,029 volumes of selected book text data delivered to countryside; 1,680 bibliographic data of Wenjin Books Award, nearly 100,000 content date, 347,000 pages of full-text books; 2,834 bibliographic data of chorography and 2,834 types of chorography full text; 278 bibliographic data of New Year paintings, 278 kinds and 339 scrolls of picture data; a total of 41 online exhibitions and 379 online lectures. The National Library plans to provide 5,000 volumes of new Chinese book for online reading service at the end of this year and afterwards provide 10,000 volumes of new Chinese book every year; meanwhile, gives full support on the construction of culture sharing project information infrastructure platform providing support, operation, maintenance service for network access, resource storage, main server and database system (Xu 2004).

National Digital Library Project and the Cultural Sharing Project both belong to public cultural services and have relative large cooperative space in technology, resources, services and other aspects. Taking "complementing each other's advantage" as the basic principles, the two parties will carry out extensive cooperation in building infrastructure platform, digital resources sharing and exchanging, the digital resource construction and service standard and norm's development, mutual cooperation and exchange of professional, personnel training, publicity and promotion, which will obtain significant benefit in resources integration and effectively improve the overall level of two projects in resources construction, technology support and information service and boost the prosperity in education and culture network resources jointly.

140.2.3 Coordination and Management the Numerous and Repeated Content on Network Education

Rich network education resources provide a lot of learning materials and teaching materials for teachers and students in the application process. In view of knowledge management, reintegrating materials is the most valuable experience of teacher. However, the present network education platform fails to explore, clear up, share and apply really valuable information data and fails to consider the construction of teaching knowledge sharing environment systematically (Liu et al. 2010). Therefore, studying the knowledge management method is also a part to improve network education resources and also an effective way to speeding up the development of network education application.

140.2.4 Establishing and Studying Teaching Evaluation System Based on Network

The current educational evaluation mainly uses summative evaluation only taking the exam at the end of semester or relevant questionnaires as the basis of the evaluation. The one-sidedness existing in this evaluation has been recognized by the public. The targeted reform measures are put forward and implemented gradually. But carrying out evaluation in long-term formative evaluation means need to put a lot of manpower, material resources and give continuous tracking observation to collect and count related information, which is difficult to achieve in the current educational environment (Zhan and Li 2009). The network, with its strong interactivity, spatio-temporal openness, convenience in collecting and managing data, personalized information exchange, efficient data statistics and analysis function, makes it possible to design and develop long-term formative network teaching evaluating system. It is also an inevitable trend for the development of teaching evaluation system, thus promoting the application and development of network education and finally realizing the optimization of teaching.

140.3 Conclusion

Improving network education resources need government, education management departments and educational institutions at all levels, as well as first-line professional teachers working together; especially, the support and investment of government is the basic material guarantee to establish network educational resources of high quality. Education management departments and teachers should start from the construction of high-quality network courses and high-quality network teaching staff, which will create a good learning environment for the network learners to enjoy independent learning and cooperative learning and allow more people to get high-quality network education.

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Chapter 141
Discussions on the Curriculum Integration of Architectural Technology and Design

Jin Zhang

Abstract In the wake of the flourishing development of construction industry in China, an increasing number of graduates majoring in architecture are needed in the market. However, an apparent discrepancy between education and the reality exists: numerous graduates couldn't assume the responsibility of independent design until they have gone through a quite long period of time for adaptation, which is, as demonstrated in this paper, correlated with the current disjunction between the architectural technology and design education. The reasons for this phenomenon have been analyzed in this paper; and based on the analysis, strategies for the curriculum integration of architectural technology and design have been proposed.

Keywords Architectural technology · Architectural design · Integration

141.1 Introduction

In the wake of the flourishing development of construction industry in China, an increasing number of graduates majoring in architecture are needed in the market, and the newly-founded domestic architecture specialties are constantly springing up. Then, are the current graduates majoring in architecture able to meet the demands made by the market? The answer is not optimistic. Numerous graduates couldn't assume the responsibility of independent design until they have gone through a quite long period of time for adaptation and have received one-year or longer-period reeducation in design institute.

J. Zhang (✉)
School of Architectural Engineering, Zhongyuan University of Technology, Zhengzhou, Henan, China
e-mail: ccqqaa2005@126.com

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141.2 Current Situation of the Architectural Technology and Design Education in China

Through years of teaching practice, one point which can be affirmed is that the discrepancy between education and the reality is correlated with the current disjunction between the architectural technology and design education. Along with the rapid social development and scientific improvement, the practical engineering technicality has turned into far more complex while the settings of technology curriculums in architectural major are dramatically laggard. Even worse, as such crucial technology courses in engineering practice, they should be seriously neglected. Obviously, the reason why architecture majors who possess severely inadequate architectural technology knowledge lay less emphasis on technicality than art is that the architectural design has been artificially dissevered from the technology courses (Qin 2002). The architectural design is the main required course throughout the five-year professional learning of architecture, which has been attached great importance by both teachers and students. However, only the graphic design and the deliberation for the architectural image are stressed in the traditional architectural design education. Meanwhile, the great support provided by architectural technology for architectural design has been ignored. Especially in some newly-founded architectural colleges, there are only two highlighted subjects—form and function from the basis of architectural design to the graduation design owing to reasons in various aspects like the field of vision, teacher resources and the traditional teaching mode etc., which would lead the students to get a one-sided understanding of "architectural design is the combination of form and function" and then pay little attention to the architectural technology curriculums that provide great support for architectural design. Thus, for lots of students, failures and mistakes would be constantly showing up because of the lack of sufficient knowledge about engineering technology (Chang 2004).

141.3 Causes for the Absence of Architectural Technology Education

141.3.1 The Absence of the Atmosphere in Architectural Technology Education

Under the profound influence of "French Beaux Arts", the architectural design more focuses on the artistic expression in domestic modern architecture education. After decades of inheritance and evolution of this conception, architectural performance has become an important criterion for judging the grades of the students' assignments. The beautiful rendering and the awesome architectural image are the factors of obtaining the teachers' favor and schoolmates' admiration, as well as the methods to achieve a good grade on the assignment (Zhang 2011).

This conception has been strengthened by the social atmosphere. Particularly in the design of multitudinous image and priority projects, the so-called “not outdated even thirty years later”, “modernized” and “magnificent” would be eventually reflected in the brilliant rendering, which has made the architectural image be the key standard or even the only standard in some occasions to decide whether the program is a success. “Architects of renderings” have been favored by the whole society.

At the same time, with a small proportion of course credits, the architectural technology curriculums are regarded as “minor subjects” by students who make light of the courses and only expect to pass them without much endeavor. Affected by this atmosphere, most students are inclined to lay more emphasis on art than the technicality, sparing no effort in searching for the materials to pursue the magnificence of the architectural image (Wang and Zhou 2004). Without any realization, they keep the same attitude of opportunism and imitation in the practical work and couldn’t be flexible in the practical engineering situations. With the profound habitual effect, this atmosphere has been spreading and extending in some new architecture colleges to a certain degree.

141.3.2 The Absence of the Curriculum Integration of Architectural Technology and Design

At present, the undergraduate education of architecture have set up many courses for architectural technology, such as architectural construction, architectural structure, architectural physics, architectural equipment, building material and so on. However, these courses are not considered as the significant part inseparable from the architectural design curriculums. Teachers of different courses are just absorbed in independently accomplishing their own part of job on the educational stream line with little connection, not to mention the part-time interdisciplinary teaching (Ji 2000). As a consequence of this teaching mode, students wouldn’t be able to timely realize the essential supportive value the architectural technology owns specific to the architectural art at school, ignoring the positive application of the architectural technology knowledge during the classes; and moreover, most have forgot all the architectural technology knowledge learned in earlier semesters when they are going to graduate in fifth grade. This bad result is vividly reflected in the low passing rate of architectural equipment, architectural structure and building material in licensing examination for architects.

141.3.3 The Absence of the Course Practice of Architectural Technology

As the architecture is a subject with strong practicalness, only by turning knowledge and education into sufficient practical use could the students deepen their comprehension of knowledge and then improve their design ability. For the moment, students in most architecture colleges and departments seem to have a relatively long internship of one semester in practice institute which is arranged by the universities or searched by students themselves. However, the actual situation is not optimistic—considering the economic interests and work efficiency, few practice institutes are willing to allow the "green hand" to participate a decent engineering design. What the interns do are trifles and the excellent architects do not have enough passion and time to explain the technical problems students have met in designing process. The design institutes, which have a better knowledge of how to perfectly combine the architectural technology and art compared with the universities, actually could not provide the students with sufficient technical practice and an opportunity of comprehension within the short term.

The timing for the internship is also a factor for weakening the practice's sound effects because the internship is always arranged at the fall semester of the fifth grade which is just a critical period of the annual exams for postgraduate schools review. Enduring double pressures of preparing for the postgraduate exam and seeking jobs, plenty of students forwardly give up the god-given training opportunity in undergraduate stage, which indicates that there is no actual practice training of architectural technology in most architecture colleges (Li 2007).

141.3.4 The Absence of the Teachers' Practical Experience and the Teaching Openness

In china, the education background has been attached remarkable attention by the public, especially by the teaching staff in universities. While as a quite stable profession under the current situation of unprecedentedly high employment pressure, being a teacher in universities is more attractive for most people. Therefore, an increasing number of highly-educated talents with only book knowledge instead of practical experience ascend to the universities' platform, which has brought a big hidden danger to the architecture teaching which possesses strong practicalness and led to a bad teaching effect of architectural technology—with insufficient practical experience and backward textbooks against the social improvement, these young teachers couldn't offer students more updated technology knowledge to support the designing idea or even are not able to answer the questions students are confused about.

Meanwhile, as the teachers' payment is not comparable to the professional architects' salary, the excellent professional architects show little enthusiasm for taking part-time classes in universities. Particularly in some newly-founded architectural colleges and departments, teachers with rich practical experience and enough opportunities of external exchange are badly needed, which has a profound influence on students' ability to effectively obtain the architectural technology knowledge associated with the advances of society.

141.4 Strategies for the Curriculum Integration of Architectural Technology and Design

The separation between architectural technology and design is a critical cause for the absence of the architectural technology in current architectural education. Through years of teaching experience, the conclusion can be drawn that the curriculum integration of architectural technology and design needs to be implemented from three aspects: teaching resources, textbook system and teaching steps.

141.4.1 Strengthen the Reconstruction of Teaching Staff by Various Measures

Teachers are organizers of the classroom teaching, and what the level of their professional skill is profoundly affects the realization of teaching objectives with high qualities. Thanks to the one-sided pursuit of teachers' education background in many domestic colleges, an increasing number of highly-educated talents with only book knowledge instead of practical experience ascend to the universities' platform, which has brought a big hidden danger to the architecture teaching which possesses strong practicalness—with insufficient practical experience and backward textbooks against the social improvement, these young teachers couldn't offer students more updated technology knowledge to support the designing idea or even are not able to answer the questions students are confused about; most of them just take the technique difficulty as a valid reason for the slaying of students' creative thoughts (Liu and Tian 2009). The following measures can be taken to raise the teachers' teaching level: (1) Promote the intercollegiate exchange at home and abroad. It's preferable for universities to strategically send front-line teachers to renowned colleges to conduct the lecture investigation, obtaining the advanced teaching experience, which would be surely a great help for rapidly enhancing teaching standards in new architecture schools. (2) Establish the long friendly linkage system between universities and design institutes. To improve the design ability and technical level of teachers and students, the activities of practical design and research shall be frequently initiated. (3) Invite the architects in design institutes to participate the teaching of architectural design course, bringing the advanced technology knowledge and designing idea outside of the textbook to students. (4) Often invite the well-known experts and architects outside the college to give lectures to make up for the deficiencies of young teachers' practical experience and technical skills.

141.4.2 Strengthen the Reconstruction of Textbooks, Setting up the Reference-Book System

Following the rapid social development and dramatic advances in technology, the new structures and materials are continually emerging, which leads to the constant ideas expansion on the architectural design. Nevertheless, with old and backward content against the practical engineering, the architectural technological textbooks in universities update information too slow to keep pace with the times, which couldn't satisfy the students' needs for learning architectural technology knowledge (Feng et al. 2011). In fact, the textbooks that have a thorough analysis and explanation on architectural image, space, technology and some other aspects are particularly scarce. Therefore, the reconstruction of textbook system shall be strengthened, taking the architectural technology as a key chapter added into the architectural design textbooks. The textbook shall be regarded as the bridge for the integration of architectural technology and design which would be favorable for students to build up the all-sided and open concept and the correct designing idea.

Besides, abundant reference books on architectural design could effectively avoid the defects existing in current textbooks. Based on the principles of "from the elementary to the profound" and "step by step", the reference books shall be complete, comprehensive and multilevel. As the reading materials after class, the reference books play a significant role in expanding the students' scope of knowledge about architectural technology and design and enhancing their professional competences.

141.4.3 Strengthen the Lateral Linkage Between Curriculums with Equal Attention Paid to the Classroom Teaching and Practical Activities

The execution of the teaching program shall be properly adjusted to make a timing fit for the courses offering of architectural technology and design as well as to strengthen the lateral linkage between curriculums, forming a teaching system mainly based on the architectural design with supportive cooperation of architectural technology causes (Ju and Ma 2009).

For instance, in the architectural construction cooperated with design courses, the theory lessons shall be given in the form of "designing first and lecturing second" instead, which can be planned form several subjects like stair construction, roof construction and wall construction etc.; meanwhile, in design classes, the students should be required to draw the architectural plan in depth and then make corresponding construction samples, which would help students with the application of architectural construction knowledge in designing process. In addition, as the architecture is a subject with strong practicalness, the training through practical engineering would enable students to preferably realize the architectural technology's strong supportive effect on the design (Baniassad 2001). Thus, it's definitely necessary to take the practice as the beneficial supplement of classroom teaching. Besides, maybe it's wise to prolong the training period to the whole year of fifth grade and allow students to do exercises and accomplish the graduation design under the joint guidance of teachers and architects in design institutes, which would bring the internship into teachers' effective management and guarantee that there is enough training time for students to greatly improve the practical ability and vividly realize the close relationship between the architectural technology and art.

141.5 Conclusion

Architecture is the combination of technology and art. The two aspects are linking closely with a complementary relationship. Correspondingly, the curriculum integration of architectural technology and design would help students with both the cultivation of artistic ability and the training of architectural technical skills. Only in this way could the graduates possessing independent working ability with profound artistic accomplishment and engineering knowledge be cultivated to meet the demands that the China's booming architectural industry have made on architects.

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Chapter 142
Teaching Practice for Resource-Based Collaborative Learning in Information Technology Environment

Xiao-qin Zhang

Abstract The teaching design of resource-based collaborative learning, as a teaching strategy, is on the basis of relevant theories of educational technology, and confirms reasonable teaching resources and knowledge by analyzing learning contents and teaching objectives so that collaborative learning can be put into effect depended on all kinds of collaborative means and interactive mode and learning effect is also improved. On the basis of relevant theories of resource-based collaborative learning, this paper takes the example of "Purchasing Management" course in vocational high school, and elaborates the teaching design process of resource-based collaborative learning in detail from four steps, that is frontend analysis, detailed design, learning process, and effectiveness evaluation and so on. The teaching practice has acquired well effect and it will offer important references for transformation and practice of education of vocational high school in China.

Keywords Collaborative learning · Information technology environment · Resource-based learning · Teaching practice

142.1 Introduction

In information technology environment, how to integrate the information technology and course, and how to teach and design the teaching process effectively, has become hot issues in the field of educational informationization. The instructional strategies of resource-based collaborative learning, lets the learners face all kinds of network learning resources in the form of collaborative learning, and conduct the independent study by building learning groups (Zhu and Dai 2009),

X. Zhang (✉)
Department of Information Technology and Business Management, Neusoft Institute of Information, Nanhai, China
e-mail: zhangxiaoqin@neusoft.com

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accordingly improves the learners' information search and operational capacity, teamwork skill, and planning and organizing skills, and at the same time promotes teaching benefits teachers as well as students and the teaching effect. This paper, taking the example of Purchasing Management course in vocational high school, introduces the teaching design process in detail, according to the theory of resource-based collaborative learning.

142.2 The Connotation of Resource-Based Collaborative Learning

Resource-based Learning can be described the learning process which lets the learners collect related resources and judge their true and false, right and wrong, and then deduce and reasoning and summarize and so on, at the last present the conclusion reasonably. This learning process is on the basis of the course learning objectives, and takes training the learners' comprehensive quality as core, and become more and more perfect and reasonable in the teacher's guidance (Zhu and Dai 2009; Bangzhong 2004). Sometimes it gives place to "independent study" (Zhu and Dai 2009).

Collaborative learning, which is also called cooperative learning, is a kind of learning process, in which some learners help each other and discuss together or share out the work and cooperate with one another in order to accomplish one learning tasks. Collaborative learning stresses the learner's organizational form, but resource-based learning is a kind of learning strategy. The resource-based collaborative learning makes the resource-based learning becomes coordination, and makes the collaborative learning face all kinds of resources. It tries to discuss the mode of collaborative learning on the basis of learning resources (Zhu and Dai 2009).

The process of resource-based collaborative learning can be reduced to four progressive stages which are frontend analysis, detailed design, learning process, and effectiveness evaluation and so on (Zhu and Dai 2009; Tongming and Zhigang 2005).

142.3 Teaching Practice of Resource-Based Collaborative Learning

142.3.1 Frontend Analysis

At this step, the teachers should analyze learning contents, learning objectives, and learner characteristics. At the same time the teachers should also analyze the feasibility of resource-based collaborative learning for the practical learning contents (Zhu and Dai 2009; Ma 2003).

Purchasing Management course has these main learning contents: purchasing process, purchasing way, purchasing plans and budget, supplier relationship management, acquisition negotiations, contract management, procurement process control, purchasing cost management, and development tendency of purchasing management and so on (Wang et al. 2011).

In the information technology environment, we establish the learning objectives of resource-based collaborative learning for this course. First, the knowledge objectives are as follows (You-qun 2007): requires the learners to know the notion of purchasing and purchasing management, and master the purchasing process and the main purchasing way like centralized purchasing and invite bidding, and understand the important significance of purchasing plans. The learners should also master certain method of developing and selecting suppliers, understand the advanced idea of supplier relationship management in supply chain environment, master some skills of acquisition negotiations and the main receipts used in the purchasing process, know the key articles of purchasing contract and development tendency of purchasing management, and master the main contents and method of purchasing cost management (Song 2010). Second, the action and skills objectives are as follows (You-qun 2007): the learners should write the purchasing plans and budget, also can write a bidding announcement and organize the bid opening, and develop suppliers by all kinds of channels, negotiate using some skills, control the purchasing process, and analyze the purchasing cost. Third is the information attainment objective (You-qun 2007): the learners should apply office software in order to write a purchasing plan, and establish the system of supplier's comprehensive evaluation and the purchasing cost analytical system. It's very important to operate the purchasing management software expertly.

Besides, the learners have studied some courses systematically like Introduction to Modern Logistics, Business Management, and Warehouse Management etc. They have the basic theory attainment of the Purchasing Management course in relevant knowledge, and they also have completed some correlated curriculums of computer application foundation, which give the learners essential capacity of data processing and software operational. In addition, most of the learners enjoy some learning items like organization planning, debate, discussion, and cooperation in teams, which are the necessary condition for learning this course.

142.3.2 Detailed Design

In this stage, what should be done are designing the learning resources and building the learning groups. It's a critical stage of concrete operations for resource-based collaborative learning mode. As the teacher, or as a learning advisor, he or she should show his or her designing ability to the full at this step (Zhu and Dai 2009).

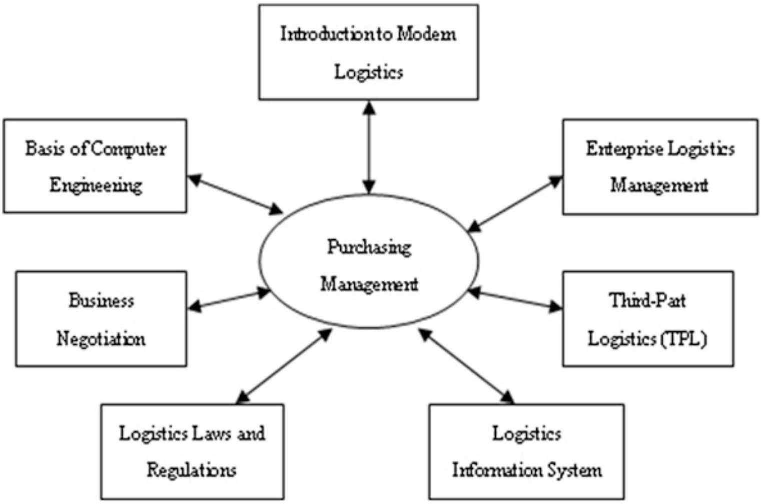

Fig. 142.1 Purchasing management's relationship of chiasma with other courses

1. *Learning resources design*: Designing the learning resources demand to consider the learning contents and teaching strategy, and should be organized round the learning need and teaching objectives (Zhu and Dai 2009). Zhu (2002) divided learning resources into learning materials and teaching environment, which is divided into resources environment and granted pass environment. Firstly, in terms of learning materials, "Purchasing Management" course in vocational high school is cross associated with many courses from the course's learning objectives and contents. For example, this course can be integrated with the courses such as "Enterprise Logistics Management" and "Introduction to Modern Logistics" for the content of purchasing work flow. For invite bidding, it can be integrated with "Third-Part Logistics (TPL)". For purchasing contract management, it can be integrated with "Logistics Laws and Regulations" as well (Zou et al. 2007). The Fig. 142.1 is this picture of Purchasing Management's relationship of chiasma with other courses. So teachers should integrate the related knowledge and learning materials of these cross-discipline subjects in forms of cases and special study websites and so on (Chunzhi and Yongsheng 2004).

Secondly, in terms of learning resources environment, we established special study websites, and take full advantage of professional website such as "www.chinawuliu.com.cn", "www.purchasingbbs.com", and "www.chinabidding.com.cn" in order to collect various kinds of learning resources. In addition, a very convenient and practical purchasing management software is applied for classroom learning. In terms of granted pass environment, our school has gigabit ethernet campus backbone, and more than ten thousand network information points spread all over in school. There are more than 100 various scale of multifunctional academic discussion lecture hall and multi-media classrooms. Every student is provided one laptop. These have formed high set of molding physics academic environment. Except traditional school library and logistics management laboratory, we set up class blog and course Twitter so that teacher and student can communicate online by forum, E-mail, QQ and Twitter, consequently promote teaching benefits teachers as well as students.

2. *Building learning groups*: Learning group, which is the basic organizational form of collaborative learning, and is built whether reasonably or not can influence quality and effect directly (Zhu and Dai 2009; Li and Li 2011). On the basis of teaching objectives and learner's characteristics, Except introducing the course's properties, objectives and contents in detail at the first class, we explain the reason of opening this course, its foundation and mysterious, its position in professional knowledge framework and use prospect, its relation with knowledge studied, its impact on follow-up courses, how to learn and examine and the gains from this course, so that learning interest of learners can be aroused. Also, we let the students build learning groups freely. Teachers confirm the foundation of building groups for its collaboration. In other words, six groups should be built in every classes, and there're five or six students in every group, and the sex ratio shouldn't be less than 1.5, and so on. Every group should elect its principal, who is in charge of division, cooperation and submitting the learning tasks of the group. Finally, for individual group not in conformity with the principle, the teacher should coordinate uniformly for the sake of the groups' harmony and diversity.

142.3.3 Learning Process

Learners should become principal part in this stage. Teamwork Skills and problem-solving ability of learners should be emphasized. Teachers should tell students what should be done, which teaching materials are needed and the deadline of finishing tasks. Also, teachers should supervise the learning process at any time, and answer any questions encountered in the process of collaborative learning (Zhu and Dai 2009; Zhou and Rao 2008).

This text will show how to design learning process specifically in detail by taking "Invite Bidding" for example. On the basis of the work flow of "Invite Bidding", the teaching contents are divided to six steps, that is, "Writing Bidding Announcement—Bidding—Bid Opening—Evaluation of Bid—Award of Bid—Discussion and Summarizing". The Fig. 142.2 shows the process.

1. *Writing Bidding Announcement*: teachers design the job task for students, that is "organizing an invite bidding for purchasing 2,500 laptops for students of our school". So at first we let learners write the bidding announcement, and release it on the class Blog. Some learning resources should be offer by teachers, such as "www.purchasingbbs.com", "www.chinabidding.com.cn", the cases of

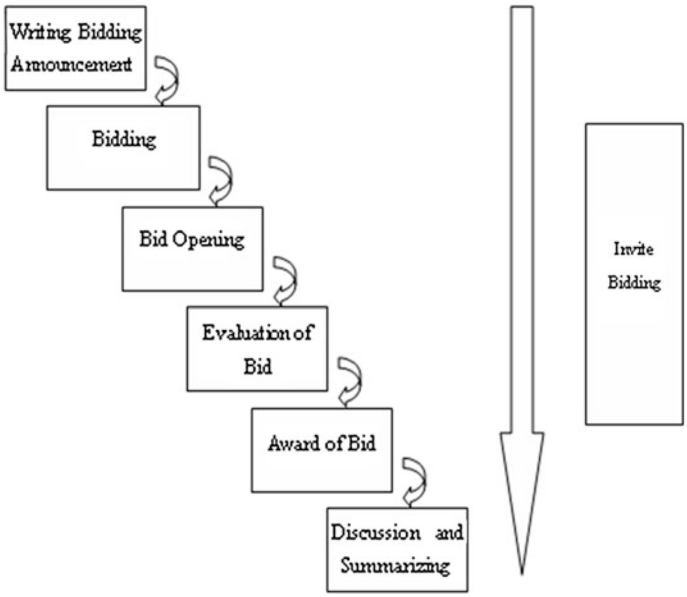

Fig. 142.2 Learning process of "Invite Bidding"

Invite Bidding and the class Blog and so on. Every student is asked to submit the bidding announcement until week 6.

2. *Bidding*: Teachers elect one excellent bidding announcement from all the students' fruit, and then every learning group is asked to fill in some relevant core files of bidding on the basis of the elected bidding announcement. The core files of bidding should be sealed in portfolio and submitted at week 7. Furthermore, teachers offer some sample plate of core files of bidding.
3. *Bid Opening*: At this step the learners are asked to organized the conference of Bid Opening and show the flow of Bid Opening. Every learning group as a bidder participates in the conference. Teachers should offer some video and glossary of Bid Opening. And learners can find references from the special study websites.
4. *Evaluation of Bid*: The committee of evaluation of bid which is built by learners evaluates the bid at scene, and then announces its result. At this step learners should know the rule and method of evaluation of bid. Also all the needed resources can be found and used with teacher's guidance.
5. *Award of Bid*: Bid-winning notice is issued to the learning group which wined the bidding. At last learning groups imitate concluding and signing purchasing contract.

6. *Discussion and Summarizing*: Learners are asked to discuss the whole process of Invite Bidding, and analyze the possible problems and the solution. Then teacher summarizes and comment by introducing typical cases and the groups performance. Finally, learning groups should write an analysis report submitted at week 8.

142.3.4 Effectiveness Evaluation

Evaluation includes formation evaluation and summative evaluation. Formation evaluation proceeds in form of learning achievement exhibition in every learning process. Summative evaluation is on the basis of whether learners reach the learning objectives or not. Objectives of resource-based learning includes course objective and information literacy objective, so effectiveness evaluation should evaluate the two fields (Zhu and Dai 2009; Feng and Zhang 2004).

The past course assessment layed particular stress on the written examination, and let teachers evaluate learners (Bao 2011). Purchasing Management is a major core curriculum, and we have changed its evaluation methods. That is, the past assessment payed attention to result and neglected learning process, now we not only stress on learning process, professional training, but also we invite corporate experts as well as teachers on campus to evaluate learner's effectiveness (Chen 2006). Learner's total score is divided into the following four parts: score of checking attendance accounts for 10 %, performance in class accounts for 20 %, professional training achievement accounts for 30 %, and final examination accounts for 40 %. So we can see the evaluation of performance in class and professional training achievement are increased, and proportion of final examination is cut short.

Checking attendance, performance in class and professional training achievement constitute the contents of formation evaluation which evaluate learners performance in learning process. During professional training achievement evaluation, students are asked for self-assessment at first, then the principal of every learning group should evaluate every member's contribution for the group, and finally teacher should evaluate learners' effectiveness of training synthetically.

For summative evaluation, on the one hand we evaluate whether students have reached course objectives or not in the form of final examination, and on the other hand "assessment mechanism by external experts" has been built in our school, that is, at the end of the semester, some known corporate experts and directors will be invited to evaluate students' professional competence. This evaluation is conducted around the technical ability of major core curriculum, and mainly evaluates learner's professional skill and information literacy. On these conditions teachers on campus can add or subtract score of student by combining the result of external experts assessment.

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Chapter 143
Dimension of Information Attainment of Senior Manager Under the Background of Fusion of Informatization and Industrialization

Xue-fei Chang and Yu-fang Chao

Abstract Chinese government has taken fusion of Informationization and industrialization as an important measure for developing modern industrial system, vigorously promoting the fusion of Informationization and industrialization of enterprises. Human resources as the most dynamic resources, stand in the heart of the fusion of the two, Information attainment of enterprise senior manager is one of the key factors which determines the success or failure of this project. This article took literature study and empirical research, through analysis of characteristics of information society and fusion requirements of the two, enriching the existing contents of concept of information attainment from such dimensions as information consciousness and emotion, information knowledge and skills, problem analysis and objective definition, project implementation control and evaluation, environment creating, lifelong learning and innovation ability. Through clearing of dimensions of information attainment of senior manager in the context of "fusion of two", we can further refine the contents and lay the foundation for studying the ways to improve it.

Keywords Informationization · Industrialization · Enterprise · Information literacy · Structure

143.1 Introduction

Information technology is one of the important means to enhance the competitiveness of enterprises, being an important supporting technology for the achievement of enterprise innovation; its strategic role has been a broad consensus. On the 16th

X. Chang (✉) · Y. Chao
School of Business, Shandong Polytechnic University, Jinan, China
e-mail: changlji@163.com

Y. Chao
e-mail: chaochuwen@sina.com

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National Congress of the Chinese Communist Party, Jiang Zemin first proposed a new road to industrialization by "using Informationization to stimulate industrialization, and using industrialization to promote Informationization". Hu Jintao President, on the 17th National Congress of the Communist Party, put forward new view of scientific development by "development of modern industrial system, vigorously promoting fusion of Informationization and industrialization", the concept of fusion of two came into being. "The fusion of two" is not only an integration of information technology and enterprise technology, impacting strategy, operation mode, organizational structure, business processes, processes of product development and manufacturing, and various other fields of enterprises, more is innovation of ideas and methods on the management. Therefore, the "fusion of two" necessarily involves internal decision-makers, all levels of management, executive Officer, and senior executives in the enterprise are critical to the success of "fusion of two". Hao (2006) noted that "fusion of two" was passively carried out due to the lack of information literacy, especially the lack of management information literacy. Jun (2008) also pointed out influences and constraints on "fusion of two" from senior management team, put forward that the "fusion of two" should focus on "people-oriented".

People, as one of the most active and most fundamental element in the application of information technology, determines the success or failure of fusion of Informationization and industrialization Wang et al. (2009). Most of points of view recognized the importance of information literacy in the fusion and recognized improving information literacy in promoting depth of fusion. But for study of improving information literacy of senior managers in depth, systematic study had not yet been carried out, specialized research for improving information literacy of senior managers had not too. It can be predicted that with the depth of "fusion of two" practice and research, research on the information literacy of senior management in the enterprise will receive adequate attention. Therefore, clearing content and structure of information literacy of senior management in the enterprise will be effective and significant to improve "the fusion of two" http://www.library/lnfoComp/definition.html.

143.2 Methodology

Under present situation, information literacy research has a short history; the definition about information literacy is not normal. Therefore, the research should take literature research and empirical approach. Through literature research we can have a better understanding of the general scope of the information literacy, through a requirement analysis of "fusion of two" in terms of knowledge, skills, and feelings on senior managers, and make further refining of dimension and structure of information literacy of senior managers. In view of the time, this article is just a preliminary study on information literacy dimension of senior managers in the enterprise; the study of specific contents will be carried out on the basis of this study, through empirical analysis by questionnaire survey (Wu 2006).

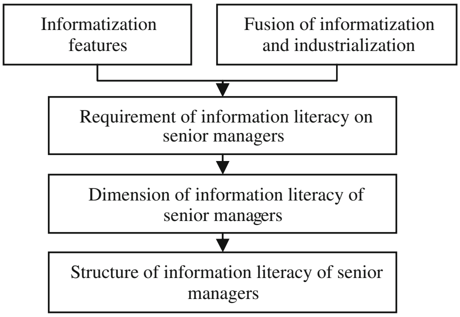

Fig. 143.1 Research roadmap

First through the analysis of Informatization features, this article tried to understand the requirement for enterprises by the information society then made further analysis of two "depth of fusion" features and key success factors and its Informatization requirements for senior managers. On this basis, through document research about the "information literacy", it analyzed the content of "information literacy" and the match of information literacy with "fusion of two". Through a combination of the two studies, it defined dimension of information literacy of senior management under the background of "fusion of two". The study roadmap of this article is shown in Fig. 143.1.

143.3 Features of Informatization and "The Fusion of Two"

143.3.1 Connotation of Informatization

There are two points of view about connotation of Informatization, social connotation and technical connotation. The technical one takes informatization as the processes of integration and application of information technology and communication technology; the social one thinks informatization as that it is the widespread use of information technologies and information resources and the forming of social life adapted to it, and establishment of corresponding system of social behavior patterns, social structures and social norms, that is the development process of the civilization into the information society. This article concluded that the "fusion of two" is not just the application of information technology in enterprises; it is innovation and transformation of the management, operation, enterprise behavior, organizational structure, and major changes in system of corporate conduct codes, social connotation of informatization is more meaningful.

In terms of social point of view, Enterprise Informationization should have three things: first, it is the universal application of information technologies and information resources, secondly, it is a new behavior patterns, organizational structure and the establishment of operation mode: Finally, it is process of social development entering the information civilization, is a process of adaptation to the information society.

For now, information development speed is fastening day by day, it is manifested mainly by the faster development of information technologies, and new emerging information technology is coming into being continually, it is also manifested by increasingly wider influence of information technology, which has widely touched all corners of society.

143.3.2 Features of "The Fusion of Two"

The "fusion of two", as a combination of Informationization and industrialization at higher level, refers to using information technology to stimulate industrialization, using industrialization to stimulate informatization, taking a new type industrialization road; information technology support is at the heart of the fusion for the pursuit of sustainable development. Informationization and industrialization are integrated mainly in such four aspects as technology, product, business and industries. In other words, the "fusion of two" includes four aspects of technology, product, business and industry-derived.

As for enterprises, they have three goals, the first one is to enhance the innovation capacity of their own, not only the development of new products, but innovation system through the fusion of the two in terms of technology, business model, resource use, extended enterprise influence, which is to be built on the basis of information. The second is to enhance the efficiency and reduce costs. The third is to maintain sustainable, low carbon and green development.

143.3.3 Informatization and "Fusion of Two" in the Enterprise

Requirements of "the fusion of two" for enterprise senior management are more explicit. First of all, as corporate senior managers, they must have the advanced management concept, modern enterprise management mode. The development of modern information technology and management, more management mode and concept are emerging, which provides support and space for this "fusion of two". From a technical point of view, informatization strategy is function strategy in overall enterprise strategy, providing services to the enterprise's overall strategy. Overall strategy and management philosophy are inseparable. It can be said that if enterprises do not have the advanced management theory and management models, the informatization is of no value. Secondly, as a top manager in the Enterprise, they should know the development and application of information technology.

With rapid development of modern information technology, new information technologies emerge, particularly the development of Internet technology. Many new concepts, new theories, new architecture, and new mode and technology have come into being with application and development of information technology application, it is no necessary for senior managers in enterprise to have in-depth and system master of these technologies, but they should understanding of them and know application value of them. Once again, senior managers in enterprise should fully understand entry points of “fusion of two”. As for such aspects, how information technology can meet the needs of enterprise management, and what application value information technology has, and what information technology is feasible, senior managers should have in-depth understanding. Only having in-depth analysis and understanding, senior managers can have sound plan to implement “fusion of two”, thereby informatization can maximally meet the needs of enterprise production and management, having the greatest value. Finally, enterprises should also create informatization climate and culture. “The fusion of two” can be seen as a transformation activity in the enterprise, it is inseparable from the support of all staff. Therefore, senior managers in enterprises should actively encourage their employees to have a correct understanding of informatization, cultivating informatization environment, forming a culture, thereby making all employees consciously put themselves into “the fusion of two”.

143.4 Dimensions of Information Literacy Under the Background of “The Fusion of Two”

143.4.1 The Connotation of Information Literacy

“Information literacy” is a new term arising from the development of modern information technology, there is no unified concept of information literacy. All common domestic dictionaries such as the Modern Chinese Dictionary have no “information literacy” entry. The original meaning of literacy is “normal accomplishment”, and accomplishment is a level which “theories, knowledge, skills, and character have reached”, from the viewpoint of word-formation, “information literacy” is a partial structure phrase, “literacy” is the center word, information is used to qualify the literacy classes, namely information literacy (Office of academic computing 1997). Information Literacy is made up of two nouns in English, in the existing dictionary there is no interpretation of information Literacy. “Information literacy” puts more emphasis on level and status which a person has reached in such terms of as knowledge, skills, and character (Lupton 2004).

First introduction of the concept of information literacy was done by Paul Zurkowki Chairman of United States information industry Association. Paul Zurkowki, in 1974, firstly used this concept, defining it as “People trained in the application of information resources to their work can be called information literates. They have learned techniques and skills for using the wide range of information tools as well as primary sources in molding information solutions to their problems" (Michael et al. 2004). He stressed information resources and information tools, thinking it as a continuation and expansion of the traditional culture. United States information industry Association, in 1979, stated from the consciousness level that value and range of information must be confirmed in application of information (American library association presidential committee on information literacy 1989). In 1989 United States Library Association "President Committee of Information Literacy" considered "To be information literate, a person must be able to recognize when information is needed and have the ability to locate, evaluate, and use effectively the needed information" (Information competence in the CSU: a report 1995). In 1990, Dr Mike Eisenberg and Dr Bob Berkowitz stated that solving model of information problem involves such steps as determining tasks, decision of strategies, searching, processing, appreciation and synthesis, evaluation (Criteria for accreditation, 10th ed. Dec 1996). Southern Association, a branch of United States Commission on colleges and schools, in 1996, defined information literacy as "The ability to locate, evaluate, and use information to become independent lifelong learners" (Hdormation literacy initiative and sep 1997). Independent thinking and problem-solving skills were added into its content. In 1997, New York Library Council of State University expanded the connotation of information literacy by adding sharing information resource, shared learning, cooperation and exchange (1996). In 2000, ACRL thought that "Information literacy is a set of abilities requiring individuals to recognize when information is needed and have the ability to locate, evaluate and use effectively the needed information.", reviewing and adopting the "United States information literacy competency standards for higher education", which has become widely adopted standards (Position statement on information literacy 1993).

From the current definition of information literacy, most definitions describe it from the perspective of information access and application, which may be associated with his subjects. Under the context of "The fusion of two", identification and application of information technology and management innovation are more vital. Therefore, current definitions of information literacy do not fit senior managers in enterprises under the background of "fusion of two", need to be further expanded on the existing basis.

143.4.2 Dimensions of Information Literacy Under the Background of "The Fusion of Two"

On above analysis, with the deepening of informatization and the level of "fusion of two" of Chinese companies, the connotation of information literacy should be richer, that definition, which is only confined from information obtaining and application, does not adapt to the development of contemporary society. Under the context of “The fusion of two”, information literacy of senior managers should be a comprehensive concept, which not only involves the mastery of information technology and information, skills, but also involves the concept of corporate management, cultural atmosphere, and emotional understanding of the information.

Combination of characteristics of information society, as well as the “fusion of two” requirement for senior management in the enterprise, information literacy should include:

1. Information consciousness and emotions

“The fusion of two” cannot be separated from the application of information technology. For the senior management in the enterprise, first of all they must have a certain awareness of information, recognizing the necessity and importance of “fusion of two “, being not exclusive to advanced information technology. Of course, as a top manager in the enterprise, having consciousness dose not mean that they must have master of information technology. Information consciousness and emotion mainly include actively facing challenge of information technology, not fearing information technology; active attitude to learn various information tools; understanding information source and often using information tools; can quickly and keen to capture various information, and ready to use information technology as basic means; believing value and importance of information technology, understanding limited and negative effect of information technology to correctly treat various information; demitting and complying with various moral specification and conventions in information contacts.

2. Information knowledge and skills

Information skills and knowledge include mastering the basic knowledge of computer applications and being familiar with internet knowledge and technology and skilled in the Internet use in the work; common understanding of information technology in enterprise production and management and ability to do something; understanding the latest developments in information technology and its applications, and so on.

3. Ability of problem analysis and objective definition

“The fusion of two” is the application of information technology in enterprises, involved into issues such as the entry application of information technology, information literacy of senior management in the enterprise should include the analysis of business problems, identifying opportunities for application of information technology, development of objectives of information technology application, and the ability to evaluate it projects.

4. Ability of control and assessment of project implementation and creating appropriate atmosphere

Enterprise top manager as decision makers, who allocate resources and implement major policy decisions, should have ability to solve conflict problems in projects implementation, coordinate the implementation of projects, and be able to create an informatization environment and establish a culture of enterprise information.

5. Lifelong learning skills

Information technology is developing continuously, management technologies and methods are in constant development, and information literacy of senior management in the enterprise should include the content of lifelong learning. Senior managers in enterprises should conscientiously learn knowledge and skills related to computers, Internet, being curious for information technology, actively learning and applying advanced information technology.

6. Innovation capacity

"The fusion of two" is not only the use of information technology, is change and innovation of the concept of enterprise production and management. Therefore, information literacy of senior management in the enterprise should include innovative ability.

143.5 Conclusion

As China's "the fusion of two" is being continued to be deepened and attention had been paid to information literacy of senior management in enterprises. This article, on the basis of existing studies, through in-depth analysis of characteristics of information society and the specific requirements "fusion of two", enrich the existing concepts of information literacy from such dimensions as information consciousness and emotion, information knowledge and skills, problem analysis and objective definition, project implementation control and evaluation and atmosphere creating, and innovation ability. Through the clarifying of the dimensions of information literacy of senior management in enterprise under the context of the "fusion of two" senior management, we can further refine its contents, laying the foundation for searching ways to improve it.

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Chapter 144
A Study of the Upgrading Paths of Industrial Clusters from the Global Value Chains Perspective

Wen-yan Lai

Abstract The global value chains theory provides a new method to upgrade industrial clusters. From the global value chains perspective, this paper analyses the existing problems in the upgrading process of China's industrial clusters, and proposes some upgrading paths: China's industrial clusters should gain access to the high-end parts, strengthen the technological innovation capability, enhance the industrial relevance, and improve the capacity of international market expansion.

Keywords Existing problems · Industrial clusters · The global value chains · Upgrading path

144.1 Introduction

As economic globalization continuously progresses, production processes gradually break down in the world, most enterprises in developed countries occupy high value-added areas, while most Chinese enterprises only have areas of low value-added. This development tendency makes us not to do our study of industrial clusters upgrading merely focusing on the level of three industries, but to explore it from the view of global value chains. With the rapid development of world economy, value creation system of the world appears unprecedented vertical separation and reconstruction, global value chains has become an important form of expression of economic globalization. If China implements active international strategy learns technology and management expertise from the advanced countries via global value chains, China will be able to enhance the industrial competitiveness effectively. In recent years, even though China's industrial clusters

W. Lai (✉)
Department of Economic Management, Guangdong Radio and TV University, Guangzhou Province, China
e-mail: 458989141@qq.com

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develop rapidly, since most of them develop under imperfect market mechanism and the low standards of whole technique and management level of industries, there is still a big disparity of competitive compared with transnational corporations, thus China's clusters are faced with alternatives of transforming or upgrading (Gong 2009). Therefore, it is needed to study China's industrial clusters upgrading problems from the point of view of global value chains.

144.2 A Correlation Analysis of the Global Value Chains and Industrial Clusters Upgrading

The world economic system in the background of globalization is like "a string of pearls", pieces of gold thread which string these pearls (industrial clusters) together are the global value chains (Arndt and Kierzkowski 2001). This metaphor vividly illustrates the relationship between the global value chains and industrial clusters.

(A) The global value chains theory

Value chains concept was first proposed by Professor Porter of Harvard Business School. He considers that value chains mean a set of processes for product design and production, product sales, until the final consumption and use of products, including all the value creation activities of the company, i.e. "the company value chains" (Porter 2007). Gerry Fong expanded the visual angle of value chains to a nation, even to the world, and developed "the global commodity Chains Theory". He lays stress on the importance of country cooperation in forming the global trade value chains (Zhou and Wu 2008). With the acceleration of economic globalization, global configuration and integration of the value chains grow in intensity. Facing this background of the big conversion of international division, the global value trains theory came into being. It discusses about products on a global scale, discusses all the value-creating activities at all life cycle of products, from product conceptual design to production and consumption until product scrapping and recycling, including product design and production, product marketing, distribution, and end user support services, etc. Its basic idea is that the global value chains are composed of many "value links", not every link creating equivalent value, value created is discretely distributed to the value chains. The global value chains are actually separated into several fragments which are generally discretely distributed to all over the world spatially. Every fragment value that is separated out generally has a characteristic of high geographical concentration, i.e. "discrete in large area, concentrate in small region".

(B) The theory of industrial clusters

The earliest research on the economic phenomenon about the globalization of industrial clusters can be traced back to Adam Smith's *The Wealth of Nations*.

In the late 19th century, Marshall described the phenomenon that a large number of relevant sector enterprises concentrate in the "industrial districts" of specific areas. Later in 1929, Weber published a book—*location of the original theory*—in which he proved the location choice of industrial agglomeration from the views of costs and benefits. From the economics of competition point of view, Porter defined "industrial clusters" as a collection of companies and organizations which are interrelated in a specific field and geographically concentrated, including interrelated industries and other entities important to competition (Porter 2007). After that, different scholars put forward different definitions of the concept of industry clusters. To sum up, "industry clusters" could be defined as a group in a particular region, with competitive and cooperative relations, which are composed of interrelated and geographically concentrated enterprises, specialized suppliers, service providers, financial institutions, manufacturers of related industries and other relevant bodies. Industrial clusters have become important economic and social phenomenon and a form of industrial organization. It can strengthen the division of labor based on specialization, play the full roles of industrial linkage and cooperation, lower innovation and transaction costs, and promote the rational flow and optimal allocation of factors of production (Chai 2008).

(C) Mechanism of industrial clusters upgrading in the global value chains

With the acceleration of economic globalization, industrial clusters, as an important carrier of the regional economic development, is now presenting new characteristics: It is embedding into the global value chains in different ways. Embedding into the global value chains enables local suppliers to obtain the opportunity of gaining market access, increase production capacity and realize the redistribution of global interests. Besides, it can also help to perfect industrial clusters network, makes enterprises possess a global perspective and have more chances to do a higher level of technology transfer and management learning. Although industrial clusters embedding into the global value chains has effect on strengthening itself continually, this process is not a straight line, it needs each economic actor's continuous joint efforts to complete. Integrating into the global industrial networks, not only provides more opportunities for cluster development, but also makes clusters face more intense challenges and competition. In the process of embedding into the global value chains, industrial clusters usually improves its own competitive capability through the core link, and then uses this opportunity to spread and extend towards a higher value added link. Facing the new global competitive situation, the first thing for enterprises of industrial clusters to consider is how to find the position which is suitable for the current status of economic structure and industry development, and then continually achieve the upgrading of industrial structure and competitiveness along a feasible path.

144.3 The Existing Problems in the Upgrade Process of China's Industrial Clusters Based on the Global Value Chains

(A) Relatively low level of development of industrial clusters, mainly concentrated in the low-end link of value chains

The overwhelming majority of China's industrial clusters are labor-intensive, mainly depending on the advantage of low cost. Their capacity of obtaining value from value chains is rather low, and their space of anti-risk on the prise is also small because of thin profit margins. In 2008, 153 among the world top 500 are American enterprises, compared with only 35 of China. America is in the high-end link of industrial chains. She controls the key links, such as product design, raw material purchase, retail and terminal, etc., and creates value accounted for 90 %. While China is in the low-end link of industrial chains in international division. Knowledge and technology diffusion is rather limited in labor-intensive enterprises. Industrial clusters formed from this are surely big but not strong, and can only obtain lower added value (Jeffrey et al. 2007). *The Wall Street Journal* once reported that in America, the retail price of Logitech wireless mice which were produced in Suzhou, China, is set at around 40 US dollars, but China only gets 3 US dollars for all the payments, including salary, power, logistics and more. The reasons for this are as follows: on the one hand, local enterprises are content with OEM mode of receiving orders and production, and lose the motivation of initiatively extending towards the high-end link of value chains, which results in cut-throat low price competition and smaller space for value realization; on the other hand, although China is abundant in labor, local industrial networks do not form unique regional brands and core brands, most products are sold in the mode of OEM sales in foreign markets, which causes that a lot of value drain away to foreign countries, while China can only earn a meager processing fees by contract manufacturing.

(B) Underpowered cluster innovation, path dependence on the exterior

The technological innovation capability of enterprises of industrial clusters is not strong, most enterprises are mainly based on applicable and simple technology application, and still remain more imitation than innovation, which causes "path dependence" on the exterior of industrial clusters. On the one hand, enterprises of China's clusters easily generate excessive dependence upon the external relations. They actively connect and participate in global industrial clusters through value chains (Zhan 2007). With a steady flow of capital, technology and management experience inputs, local enterprises usually generate heavy reliance on multinational corporations, which leads to a serious lack of innovation capability. Besides, as compared with the high-cost inputs the firm's own designing, research and development (R&D) need, the costs for continuing knowledge and technology diffusion of external advanced clusters is much cheaper, and the risk is also lower, which leads to the absence of independent innovation ability. On the other hand, the level of technology of China's industrial clusters is relatively low; the mechanism of interactions between universities, research institutes and enterprises of industrial clusters is not perfect; China's patent results transformation rate is slow; China lacks high-quality personnel. All of these make the R&D capacity of enterprises of industrial clusters weak (Hou and Wang 2009). According to statistics, China's patent technology transformation rate is less than 1 %, which causes serious waste. The root causes of a large number of unused patent results are: production, R&D is out of touch with the market, and the R&D results fail to meet the market demand.

(C) The lack of the basis of clusters' social networking, relatively poor industry relevance

At present, the situation of many vicious competitions among clusters exists in China. The lack of the basis of social networking and many deformed internal industrial chains lead to a high level of homogeneity within products of industrial clusters, more competition than collaboration among enterprises, and poor industry relevance. Failing to construct high-tech industrial zones by imitation which is found everywhere in China is a case in point. In the meantime, industrial clusters are also facing the challenges from foreign advanced technology industrial clusters, which arouses China's clusters' exclusion against foreign countries and forms the situation that various industries fight separately, shutting the door on others, leading to the relative lack of synergistic effect. Industry associations are an important part of social service system. Many small enterprises can be connected as a whole through associations, which helps to promote both division of labor and cooperation between enterprises. However, there are no trade associations and other coordinating bodies in many industrial clusters in China. Due to the lack of complete service networks and functional platforms, the cluster development models around the country are quite similar, which restricts the competitive advantage of industrial clusters from bringing into play (Xu 2010). Take China ceramic industrial cluster for example, a large number of enterprises from Guangdong, Shandong, Fujian, Hebei, Sichuan, Zhejiang and other places, pour into the ceramic industry, leading to the rapid expansion of production capacity. Outwardly industrial clusters in different regions have different advantages, but it is difficult for industrial clusters to develop their comparative advantages in a relatively short period of time.

(D) The lack of strategic partners of core enterprises in the global value chains, difficult to promote the optimization and upgrading of industries

Economic globalization embeds industrial clusters into the global industry development networks. The optimization and upgrading of industrial clusters is a process in which industrial clusters realize sustained upgrading in the global value chains dominated by multinational companies by maintaining, increasing, creating and capturing value. Core business partners of foreign value chains make a significant contribution to industrial clusters upgrading. However, China's industrial clusters always lack investment partners of core strategy links in the global value chains, which means there are hardly any core businesses of the global value chains doing any joint venture with enterprises of clusters, or doing any strategic cooperation in designing, R&D, production and operations, and marketing channels. For most exogenous clusters, due to the lack of core business partners of value chains, export processing enterprises stagnate at the stage of OEM production for a long time, and lack their own brands. In order to maintain their technological competitive advantages, multinational corporations leave core technology and core product development, designing and production behind in home country, making the spillovers of knowledge, technology and management experience rather limited; Some system defects also hinder the path of direct investment technology spillovers from multinational corporations; Some multinational corporations adopt the actions of exclusion and suppression against China's industrial clusters embedding into the global industry value chains, etc. All of these seriously affect the upgrading and optimization of China's industrial clusters.

144.4 The Upgrading Path of China's Industrial Clusters Based on the Global Value Chains

(A) Change its position in the global value chains, gain access to enter the high-end link

In different types of industries, various specific links of the value chains have their own characteristics, and value distribution of each value chain is also different from others. Value analysis enables the clusters to find appropriate market segments, determine the best way to cut-in, adjust the links of the global value chains, and achieve the upgrading of links. Enterprises of industrial clusters should according to their competitiveness, meticulously divide every link and the source, composition and distribution of the value in related industry value chains, and then determine a clear market role and targeting (Wang 2007). Enterprises should also fully use external contact networks to explore the links which have greater potential of increasing value in the global value chains, and determine their "strategic links" in the global value chains (Humphrey and Schmitz 2002). Moreover, China should accelerate the formulation and promulgation of China's own industry standard, protect China's core competencies, enhance the ability to address the financial crisis, and help Chinese enterprises directly enter the terminal and high-end link of the global value chains. If industrial clusters want to gain higher levels of competitive advantage, they must innovate continually, overcome the shortcomings of comparative advantage, surpass cluster competitive advantage rigidity, and integrate themselves into a higher level of global industry development system. Enterprises of industrial clusters should also according to the size of added value, analyses the value of each link, fully use capital, technology, management and other resources of the value chains, continually improve their own international competitiveness, and eventually shift the focus of cluster enterprise development from the low-end link of the value chains to the high-end link which is mainly on technology, knowledge, R&D, brand, standard, etc.

(B) Enhance the technological innovation capability of the industrial clusters, achieve industrial upgrading

First of all, government should encourage, support and guide enterprises of industrial clusters to innovate independently from the policy-making, environment-creating, and investment in R&D-increasing, etc., and provide an excellent hardware support for networking. The national, provincial and municipal departments responsible for the allocation of innovation funds should be inclined to industrial clusters properly, so that clusters can attract innovation resources gathered from various aspects, and attract multinational regional R&D centers and R&D headquarters of leading domestic enterprises to settle in, making innovation a driving force for the development of industrial clusters. Secondly, enterprises of industrial clusters should strengthen R&D institution building, strengthen the construction and management of the operational mechanism, funding input, development results, and other aspects of the R&D institutions, and enhance enterprise capacities for self-development. What's more, enterprises should focus on the need of industrial clusters upgrading, take a form of joint production, knowledge and research, collect and obtain a number of advanced technologies and core technologies, and enhance the level of industrial technology (Yan 2011). Finally, enterprises of China's clusters need to reduce their reliance on external, and avoid the impact of financial crisis. The global value chains are in a continuous dynamic change, therefore, China's industrial clusters ought to continuously explore their own endogenetic factors, use clusters' self intensification effect and accumulation effect, take the initiative to continuously change their own position in the global value chains, minimize their dependence on external. Technology innovation should be based on the market orientation, throughout the whole process of achieving market value. It can help to increase the technological content and added value of products, and enhance the competitive advantage of export products (Zhang et al. 2008).

(C) Industry associations should play the role of bridge to enhance the industrial relevance

Government need to formulate a corresponding "industrial clusters plan" to guide the rational distribution of the whole industrial chain, actively guide cooperative relationship between enterprises within industrial clusters, and establish cooperation mechanisms. The cooperation mechanism should be formed aiming for connecting related or complementary enterprises and sharing resources. Gathering the same or similar input elements of production process in a certain area can help to realize resource sharing between enterprises. By combining the advantages of cluster technologies, strengthening the intrinsic relevance of unit technology in the technology system, promoting cluster members to innovate and cooperate, government can effectively promote the development of the network of technology industrial clusters. At the same time, industrial clusters should grasp the dynamic change of global industries, actively obtain external resources, change the "multi-cluster" model from "homogeneous competition" to "heterogeneous complementary", so that they can overcome the rigid defects of strategic convergence of various horizontal enterprises in the industry value chain, and form the advantages of dislocation competition. Moreover, government should guide and support industrial clusters to develop industry associations, let them play an active role in promoting industry upgrading, safeguarding enterprises' legitimate rights and interests, standardizing the market order, unfolding vocational training and implementing industry self-regulation, etc., and actively make them become platforms for international cooperation and exchange and for responding to trade friction (Wei 2003). Industry associations should play the role of bridge between government and enterprises to help industries for developing markets, allocating resources, maintaining the market order and developing industry standards, etc.

(D) Improve industrial clusters' capacity of international market development, promote the optimization and upgrading of industrial clusters

Industrial clusters should strengthen the connections with the core businesses of the value chains and the relevant international economic organizations, try to obtain guidance and support from international institutions, improve industrial clusters' capacity of value capture. The UNIDO Business Partnership Programme is exactly a noteworthy effective channel for industrial clusters to embed into the global value chains; the business partnership has become an important carrier for the United Nations to stimulate industrial development at the local and international levels. Enterprises of industrial clusters ought to use their own existing industrial base to attract those core enterprises of the international value chains to enter their industrial clusters, so that they can use multi-dimensional external links to strengthen collaboration, fully obtain plenty of knowledge and information, and upgrade the internal forces of the clusters (Lu and Zhao 2010). For industrial clusters in the value chains, strengthening the collaboration with the core enterprises of the value chains can help them to get different degrees of enhancement of process and product innovation. By continuously exploring clusters' own endogenetic factors, using clusters' self intensification effect and accumulation effect, taking the initiative to continuously change their own position in the global value chains, and continuously adjusting the way of embedding into the value chains, industrial clusters can certainly promote their optimization and upgrading.

144.5 Conclusion

In the era of economic globalization, enhancing the international competitiveness of industry, gradually occupying the high value-added links of the global value chains, strengthening internal cooperation within industrial clusters, and trying to get the chances to cooperate with the core enterprises of international value chains, are the effective ways of upgrading industrial clusters. In the prospects for the future cluster development, successful industrial clusters will strive to climb to the upstream link of the global value chains, continuously innovate and upgrade themselves to create sustainable competitive advantages, and eventually become an influential force in the global economy through this path of accumulation.

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Chapter 145
Analysis on the Effect of the National Essential Medicine System in Rural Township Health Clinics: Based on the Survey Data from Rugao City in Jiangsu Province

Ming-fang Wang

Abstract To understand the present situation of implementation of the national essential medicine system in rural primary health care sectors of China, the economic impact on rural residents with the implementation of essential medicine system is analyzed to provide a reference to improve the national essential medicine system. The study investigates 48 township health clinics in Rugao City, Jiangsu Province and analyzes the survey data by the method of descriptive statistics and inferential statistics. The township health clinics take on a phenomenon called "one up and two down" after the implementation of essential drugs. The paper points out that a sound compensation mechanism of the primary health care sectors should be established by the relevant departments. Focusing on the effect of publicity, the publicity of the national medicine system needs to be improved and the training and education on the use of essential drugs should be enhanced.

Keywords Township health clinics · National essential medicine system · Essential drugs · Drugs to support medical

145.1 Introduction

The problems of "Agriculture, Rural areas and Farmers" is the fundamental ones of the party and state, in which rural health work is directly related to the protection of rural productive forces, the revitalization of the rural economy and the maintenance of coordinated development of rural society. It is also related to the improvement of the living quality of farmers and the social progress in rural areas. By implementation

M. Wang (✉)
College of Engineering, Nanjing Agricultural University, Nanjing, China
e-mail: wmfxhbl@sina.com

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the essential medicine system in rural areas, being fully equipped with essential drugs and carrying out the zero sales slips, this system will cover more people and achieve greater effectiveness (Jia 2006a, b). It is significant for the majority of the villagers to ensure equitable access to safe, economical and effective essential drugs, to control drugs cost, to reduce the economic burden of diseases, and to avoid the poverty caused by illness (Ministry of Health of the People's Republic of China 2009). Township health clinics, which are the public welfare and health services agencies held by County Government, are the hub of the three-tier level health care network in rural county, township and village (Wang 2010). In order to understand the implementation of the national essential medicine system in rural areas, the research group visited some township health clinics in rural areas and conducted surveys to study and analyze the impact of the implementation of national essential medicine system on township health clinics operation.

145.2 Research Objects and Methodology

145.2.1 Research Objects

Researches on the essential drugs operating conditions from August to December in 2010 and from August to December in 2011 are carried out in rural primary health care sectors. The survey was conducted in 48 township health clinics in Rugao City, Jiangsu Province obtain the relevant data including the outpatient data which include the total income of outpatients, outpatient drugs income, outpatient essential drugs income and the inpatient data which include the total income of inpatients, inpatient drugs income, inpatient essential drugs income and so on. In order to understand the implementation of the national essential medicine system in rural areas, 48 township Health Clinics are divided into two groups. One group consists of 14 township health clinics which started a pilot implementation of the national essential medicine system and universally accessed to essential drugs in August 2011. The other group consists of 34 township health clinics which started to universal essential drugs from August 2011 without the pilot.

145.2.2 The Survey Methodology and Data Processing

The data used in this study come from statistical data and interviews by the research group's site investigation. Some other data come from the administrative department of health website. The survey data is processed by Spss17.0 package (Xue 2000). The methodology combining descriptive statistics and inferential statistics is used to analyze the quantitative data. The methodology of classification, induction and extraction is used to analyze the qualitative data by topic.

145.3 Survey Results and Analysis

145.3.1 Analysis the Results of Survey Data from 14 Township Health Clinics

The output results shown in Table 145.1 are gotten by statistical analysis and differences comparative analysis on the survey data about the outpatients and inpatients, total income, drugs income, medical income and so on from August to December in 2010 when the essential drugs is piloted and from August to December in 2011 when the essential drugs is popularized.

Table 145.1 shows that, comparing with the data about pilot, the outpatients increased 1,015 per month after the national essential medicine system is popularized. The total outpatient expenditure for each person decreased 28.448 yuan than that in the pilot. In which the outpatient drugs expenditure decreased 24.449 yuan for each person than that in the pilot. The *P* values which are 0.011, 0.003, 0.000 respectively in comparison and contrast test are less than 0.05. Therefore it can be inferred that the changes about the data of outpatients after the national essential medicine system is popularized are significant comparing with that in the pilot. Similarly, the data about inpatients increased 9 people while the total inpatient expenditure for each person decreased 12.572 yuan than that in the pilot. Among them, the inpatient drugs expenditures decreased 20.924 yuan for each person than that in the pilot. The *P* values which are 0.062, 0.915, 0.837 respectively in comparison and contrast test are more than 0.05. Therefore it can be inferred that the changes about the data of inpatients after the national essential medicine system is popularized are not significant comparing with the pilot.

Table 145.1 Paired samples statistics and test

	Pilot	Popularized	Difference between pilot and popularized	t-value	p-value
Outpatients	2541.429	3546.014	−1004.586	−2.967	0.011
Inpatients	90.357	99.300	−8.943	−2.046	0.062
Total outpatient expenditures each person	106.998	78.549	28.449	3.572	0.003
Outpatient drugs expenditures each person	65.580	41.131	24.449	4.840	0.000
Total inpatient expenditures each person	3145.735	3133.163	12.572	0.109	0.915
Inpatient drugs expenditures each person	1951.871	1930.946	20.924	0.211	0.837

145.3.2 Analysis the Results of Survey Data About 34 Township Health Clinics

The output results shown in Table 145.2 are gotten by statistical analysis and differences comparative analysis on the survey data such as the outpatients and inpatients, total income, drugs income, medical income from August to December in 2010 when the essential drugs is not popularized and from August to December in 2011 when the essential drugs is popularized.

Table 145.2 shows that the outpatients increased 945 per month after the essential drugs are popularized than before. The total outpatient expenditures for each person decreased 21.409 yuan than non-popularized. In which the outpatient drugs expenditures decrease 15.595 yuan for each person than non-popularized. The P-values which are 0.000, 0.011, 0.000 in comparison and contrast test are less than 0.05. Therefore it can be inferred that the changes about the data of outpatient after the national essential medicine system is popularized are significant comparing with non-popularized. Similarly, the inpatients increased 24 people while the total inpatient expenditures for each person increased more 155.450 yuan than non-popularized. Among them, the inpatient drugs expenditures decreased 14.31 yuan for each person. The P-values which are 0.06, 0.177, 0.884 in comparison and contrast test are more than 0.05. Therefore it can be inferred that the changes about the data of inpatient after the national essential medicine system is popularized are not significant comparing with non- popularized (Jia 2006a, b).

It can be seen that the township health clinics take on a phenomenon called "one up and two down" after the national essential medicine system is popularized by comparing Table 145.1 with 145.2. In the two sets of data, outpatient services that are increased by 39.528 and 47.528 % have risen dramatically. The outpatient cost for each person dropped significantly that an average of the total outpatient expenditure reduced by 28.449 yuan and 21.409 yuan, a decrease of 26.588 and 20.037 %. Among them, drugs expenditure for each person reduced by 24.449 and

Table 145.2 Paired samples statistics and test

	non-popularized	Popularized	Difference between non-popularized and popularized	t-value	p-value
Outpatients	1988.706	2933.894	−945.188	−4.235	0.000
Inpatients	72.647	96.788	−24.141	−2.642	0.060
Total outpatient expenditures each person	106.846	85.437	21.409	2.690	0.011
Outpatient drugs expenditures each person	64.541	48.946	15.595	3.968	0.000
Total inpatient expenditures each person	3081.089	3236.539	−155.450	−1.380	0.177
Inpatient drugs expenditures each person	1990.841	1976.532	14.310	0.147	0.884

15.595 yuan, decreased by 37.224 and 24.163 %. At the same time, there is a clear decline about the business income of township health clinics. It can be seen that the majority of rural residents obtain benefit by the implementation of essential drugs policy which canceled the drugs addition, and drugs are cheaper than before.

145.4 Suggestions and Countermeasures

It is an important measure to deepen the medical and health system reform for China government to establish the national essential medicine system. It relates to the basic rights of everyone to enjoy the health services, to promote the rational use of drugs, to reform a phenomenon called "Supporting medicine with drugs" in medical institutions and ease the medication burden of patients. The effective measures must be taken to solve the problems and to ensure the policies to be promoted continuously during the investigation. To ensure people to "dare to take drugs when they are sick and hospitalize when they are ill". The people will no longer worry about seeing a doctor for medical treatment in rural areas. The medical staff also generally feel that the primary medical conditions are improved significantly, the number of visits who are ill are increasing gradually and the relationship between physician and patient is more acute and harmonious (Zhang et al. 2011).

145.4.1 Sound Compensation Mechanism in Township Health Clinics

It is one of the core contents of the medical reform with the use of essential drugs to the implementation of zero sales slips (Ministry of Health of the People's Republic of China 2009) in township health clinics. The income structure of the township health clinics is so single that drugs revenue accounts for a large portion of the total business income up to 60 $\sim$ 70 % (Xin 2010). Township health clinics are required to reach the utilization rate of 50 % in 2011 which is growing year by year until all use of essential drugs after the national essential medicine system is popularized. This leads that the revenue of township health clinics fall sharply. Therefore, it is particularly urgent for township health clinics to be improved the compensate mechanism. Whether the compensation mechanism is in place as soon as possible will directly affect the enthusiasm of the medical staff, as well as enforcing strength on the grass-roots level and thereby affecting the effectiveness of national essential medicine system. Therefore, the Government should assume the responsibility of financial investment and use the approach of "pre-allocation and post-settlement" on the basis of careful research and reasonable definition on revenue and expenditure of basic health care sectors. Funds is allocated monthly to the grass-roots health care sectors in time to ensure the effective implementation of the national essential medicine system and to solute the medical phenomenon called "Supporting medicine with drugs" fundamentally.

145.4.2 Increase the Input of Medical Equipments in Township Health Clinics

Great changes in outpatient services in township health clinics occurred after the implementation of the national essential medicine system. But the hospital business has not been accompanied. On one hand, the data of inpatient has small changes after the pilot and popularization of the essential drugs. On the other hand, there are small changes in total inpatient expenditure and inpatient drugs expenditure for each person. The reason is that there is inadequate investment in the input of the medical equipments investment in the township health clinics. For example, the price of the basic medical equipments is generally less than 100,000 yuan, let alone more than 500,000 yuan. There is a minimal impact of the implementation of the national essential medicine system on the inpatient due to lack of medical equipments. Therefore, it is necessary to increase investment in medical equipments in township health clinics. This can ease the overcrowding of large hospitals to a certain extent.

145.4.3 Quantitative Examination, Further Strengthening the Regulatory

Requirement for the township health clinics is that the proportion that the essential drugs sales revenue accounted for the revenue of all drugs sales which are converted should be more than 50 %. All drugs sale revenue must be divided by a coefficient. It is found that the coefficient is different in different areas. It is 1.5 in some areas and it is 1.3 in some other areas. It is to say that the determination of coefficient is of haphazard. Therefore the health authorities are required to implement the rigorous quantitative assessment on the township health clinics under its jurisdiction. Performance appraisal system about the implementation of national essential medicine system must be established soundly. It is ensured that essential drugs are implemented zero sales slips and reduce the burden of patient medication effectively through careful implementation of the pricing policy of essential drugs, strengthen the daily supervision, and severe punishment on the price violations behaviors.

145.4.4 Improvement the Publicity of the National Medicine System and Focusing on the Effect of Publicity

As long as the township health staffs and the majority of rural residents fully understand and accept the national essential medicine system, this system will play its role better. However, the research found that the penetration rate about essential drugs in pilot areas was significantly higher than non-pilot areas. The rural residents in some areas know less about the national essential medicine system and are lack of understanding of the essential drugs. It is required to improve the publicity methods on the basis of the present publicity. First, the medication behavior of the grass-roots medical staffs must be guided and regulated. The doctors' medication tends to be reasonable, scientific and standardizing by strengthening the primary medical staff training and assessment, encouraging the supervision of the use behaviors about essential drugs on primary health care sectors and medical staffs by using the information system. Secondly, the state should take a variety of promotional measures to promote the national essential medicine system. Publicity mainly concentrated on what essential drugs are, especially on the advantage of essential drugs and clarification the misconceptions that essential drugs is equal to the "bad medicine", essential drugs reimbursement system and so on. Community level should also improve the publicity through posters, panels, columns, and community physicians. At the same time, other forms of activities such as community cultural activities can be held to deepen residents understanding about the policy, to increase public trust in the essential drugs, to understand the common sense of rational drug use, to guide the patient, to change the drug habit, and to promote clinical preferred and the rational use of essential drugs.

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Chapter 146
Cloud Platform Framework of Lifetime Cycle Assessment for Engineering Materials

**Li-jun Zhang, Wei-dong Zhang, Xin Aixinjueluo,
Peng Shi and Yi-bo Ai**

Abstract Industrial products quality is more and more expected. As most products may be the organic combination of several kinds of materials, materials databases are essential to the industrial engineering. With the new IT technologies, cloud computing and Internet of Things, the materials databases have the new development path. In this paper, we proposed a new cloud platform framework, material cloud (MatCloud), of lifetime cycle assessment for engineering materials. The proposed MatCloud platform is based on the requirement of materials science/ engineering and cloud computing. By the MatCloud platform, we may overcome the limitation of the traditional materials databases. The key technologies and the prospect of the MatCloud platform were detailed analyzed. And the MatCloud platform will be gradually improved in the future.

Keywords Cloud computing · Engineering materials · Lifetime cycle assessment · Materials cloud (MatCloud)

146.1 Introduction

With the rapid development of advanced manufacturing industry, higher request of industrial products quality is expected. And research from different disciplines is aimed to improve the quality of industrial products. From the theory of system engineering, the whole lifetime cycle should be emphatically considered.

From a micro view, most industrial products may be the organic combination of several kinds of materials. And metal, the most common materials, has been used for a long time (Lu 2010). So, we should also introduce the whole lifetime cycle of

L. Zhang · W. Zhang (✉) · X. Aixinjueluo · P. Shi · Y. Ai
National Center for Materials Service Safety, University of Science and Technology Beijing, Beijing 100083, China
e-mail: zwd@ustb.edu.cn

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materials to industrial engineering. Now, a plenty of materials databases have established to develop or evaluate new materials and structures. However, the limitation of current databases, such as the data scattering, low quality of data, regulates the development of lifetime cycle assessment for materials (Sun et al. 2010; Freiman and Rumble 2012).

In recent years, Internet of Things (Atzori et al. 2010), cloud computing (Xu 2012) and other new information technologies have taken the emerging industry reform. In this paper, a new cloud platform framework of lifetime cycle assessment for engineering materials will be presented.

The rest of this paper is organized as follows. Section 146.2 summarizes the requirement of lifetime cycle assessment for engineering materials. In Sect. 146.3, typical applications (cloud manufacturing) based on cloud computing are reviewed. And the concept of materials cloud (MatCloud) is proposed in Sect. 146.4, followed by prospect of cloud platform framework for engineering materials in Sect. 146.5. Finally, conclusion is drawn in Sect. 146.6.

146.2 Requirement of Lifetime Cycle Assessment for Engineering Materials

146.2.1 Whole Lifetime Cycle of Engineering Materials

On June 24, 2011, the US President Obama announced a $500-million-plus initiative, Advanced Manufacturing Partnership (AMP). As an important component of AMP, the Materials Genome Initiative (MGI) is proposed (National Science and Technology Council. http://www.whitehouse.gov/sites/default/files/microsites/ostp/materials_genome_initiative-final.pdf). MGI is similar to the Human Genome Project in a way. In China, the 14th Special Session of Xiangshan Science Conferences convened from December 21–23 in 2011 in Beijing to prepare proposals for MGI program in this regard. Chinese scholars and experts from different fields were invited to have in-depth discussions on materials genomes (Office of Xiangshan Science Conferences. http://www.xssc.ac.cn/xs/showconf.asp?tid=4&pid=292).

MGI framework is the next generation of materials database. And in order to establish the whole lifetime cycle of engineering materials, we should integrate the different stages of materials data. Generally speaking, the whole lifetime cycle of engineering materials is composed with discovery, development, property optimization, system design and integration, certification, manufacturing and deployment. In different stages, the requirement of fundamental data, the designing data, the experimental data and the application data, is varied. Table 146.1 shows the varied data of the lifetime cycle assessment for engineering materials. And all data should be integrated and analyzed by some mathematical methods (Hillis et al. 2002; Zhang et al. 2008)

Table 146.1 Data of lifetime cycle assessment for engineering materials

	Fundamental data	Designing data	Experimental data	Application data
Discovery	M	M	L	N
Development	L	M	L	L
Property optimization	M	M	M	L
System design and integration	L	M	M	L
Certification	L	M	L	L
Manufacturing	L	L	L	L
Deployment	L	L	L	M

M More data; *L* Less data; *N* NULL

146.2.2 Challenges of Lifetime Cycle Assessment for Materials Database

From the published literatures, the materials database of lifetime cycle assessment still faces the following challenges.

1. The current databases of engineering materials are dispersed, especially lack of the databases of lifetime cycle assessment for engineering materials.
2. The quality of existing data is hardly ensured. So, materials data cannot be directly applied to the application. The data users may be afraid that the data is unreliable and incomplete. And the data providers would rather share "bad" data than "good" data with others.
3. The unified platform framework is required to integrate the different materials data. The researchers of whole lifetime cycle for engineering materials can share their data, models, methods with others via the unified platform.

146.2.3 Cause Analysis of the Challenges

The technical and also non-technical problems are reasons of the above challenges.

1. As we known, some technical problems, such as network security, network bandwidth and encapsulation of the services, may affect the development the materials database. The requirement of users far exceeded the service ability of materials database a few years ago.
2. And the most important reasons are non-technical problems, such as the management system and ideological concept. Commercial benefit of different companies restricts sharing of materials data. For instance, the data user will not pay or do not willing to pay, and on the other hand, the most investors do not use the database really.

146.3 Typical Application Based on Cloud Computing

146.3.1 Basic Concept of Cloud Computing

The concept of "cloud computing" was first proposed in 2007. It is built on existing advanced technologies such as clustering, grid computing and parallel computing, including virtualization technology.

Cloud computing is simply a platform where individuals and companies use the Internet to access endless hardware, software and data resources for most of their computing needs (Armbrust et al. 2009). In the cloud computing model, the user application does not run on the PC or mobile phones, but running on a large-scale server through internet. The data is not stored locally, but stored in the data center. The cloud computing provider responsible for managing and maintaining the data center to ensure the computing power and storage space enough for end-users. So the users can access these services with any terminal equipment at anytime, anywhere.

Infrastructure-as-a-Service (IaaS), Platform-as-a-Service (PaaS) and Software-as-a-Service (SaaS) are three common types of service delivery models (Crago et al. 2011).

146.3.2 Basic Concept of Cloud Manufacturing

Applications based on cloud computing have formed several typical applications in recent years, such as government, education, health, and manufacturing. And the concept of cloud manufacturing is shown as follow.

"The concept design anywhere, manufacturing anywhere", cloud manufacturing, is proposed (Heinrichs 2005). Cloud manufacturing is a computing and service-oriented manufacturing model. It has been considered as a new multi-disciplinary domain that contains technologies such as networked manufacturing, manufacturing grid, virtualization, Internet of Things, and cloud computing.

In cloud manufacturing, distributed resources are encapsulated into cloud services and managed in a centralized way (Zhang et al. 2010; Tao et al. 2011). Clients can request services ranging from product design, manufacturing, testing, management and all other stages of a product lifecycle. A cloud manufacturing service platform performs search, intelligent mapping, recommendation and execution of a service.

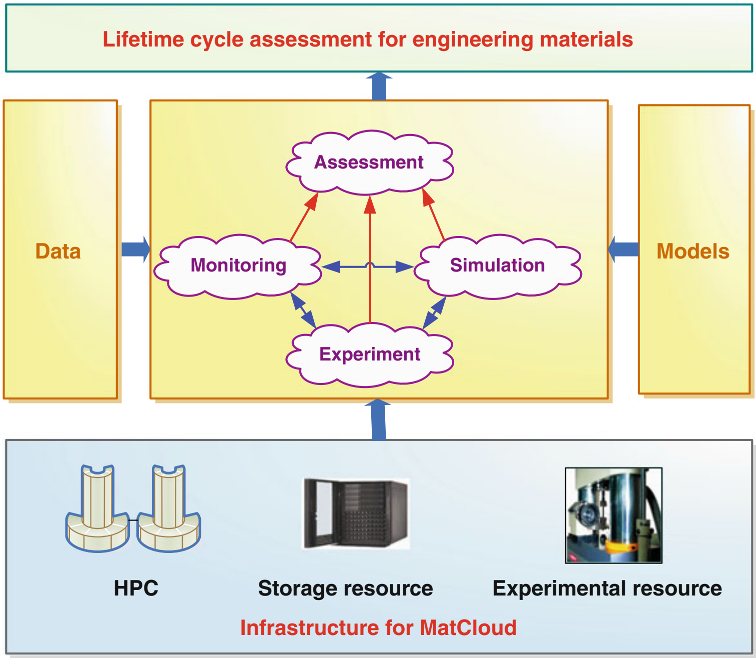

Fig. 146.1 Logical diagram of MatCloud platform for lifetime cycle assessment

146.4 Concept of Materials Cloud

146.4.1 Development of Materials Database Based on Cloud Computing

Materials cloud (MatCloud) was first proposed by National Center for Materials Service Safety (NCMS), University of Science and Technology Beijing, in 2012. In the MatCloud platform, there are four layers, the resource layer, the database layer, the tool layer and the application layer (Zhang et al. 2012).

The MatCloud platform is based on the requirement of materials science and cloud computing. And the MatCloud platform can provide the knowledge for materials designing, manufacturing, service, and so on. The logical diagram of the MatCloud platform is shown in Fig. 146.1.

146.4.2 Key Technologies of MatCloud

1. Data acquisition based on Internet of Things. The whole lifetime cycle of engineering materials will generate a lot of fundamental data, designing data,

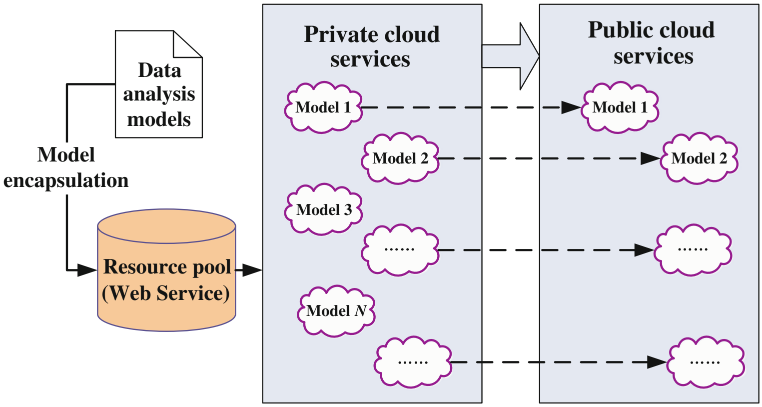

Fig. 146.2 Schematic diagram of model encapsulation

experiment data and application data. And among these data, the application data (i.e. the field monitoring data) are the most essential to safety assessment of engineering materials.

The Internet of Things technology may provide a more comprehensive method of status perception. And in the MatCloud platform, we should arrange more sensors to monitor the service status of engineering materials. The MatCloud platform will integrate the monitoring data to the uniformed system.

2. Encapsulation for data analysis models. The MatCloud platform includes the data and models for lifetime cycle assessment of engineering materials, and shares with others.

Data analysis models should be encapsulated to Web Service. Considering the security, models of private cloud services and public cloud service should be different, as shown in Fig. 146.2.

3. Traceability mechanism of materials data. In the traditional way to a scientific research, after the research, a large number of experimental data have been set aside. And these data will be difficult to reuse. Via the MatCloud platform, all the data about the materials research can be integrated. And the original researcher and the others will obtain the data in the future, with the permission.

In the MatCloud platform, the traceability mechanism will be established. The whole information about any data can be prepared with the principle, “if the one provided the data, he will validate the data and retain the ownership of the data”. Of course, if required, the data can be validated by the third-party experts. After the validation of the data, one pays for the rights, and one charges for the responsibility.

146.5 Prospect of Cloud Platform Framework for Engineering Materials

146.5.1 Application Mode Architecture of MatCloud Platform

The application mode architecture should be considered for the MatCloud platform. The C2C (consumer to consumer) model, such as eBay or Taobao, will be used in the MatCloud platform. More and more users would like to get their requirement for lifetime cycle assessment of engineering materials. As mentioned in Sect. 146.4, the traceability mechanism for materials data will be strengthened.

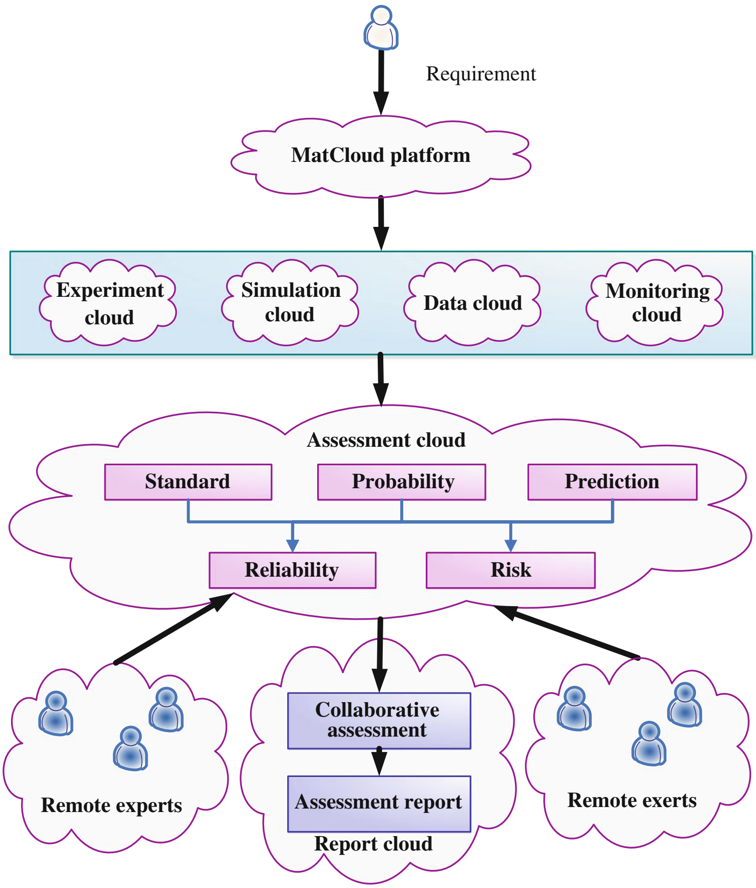

Fig. 146.3 Remote safety assessment flowchart based on MatCloud platform

In order to benefit from the materials data, the third-party payment (PayPal, Alipay, etc.) will be used. Of course, for basic materials data, it is recommended that the material cloud platform provides free services for the users.

146.5.2 Application Case of Remote Safety Assessment for Engineering Materials via MatCloud Platform

In the MatCloud platform, the Web Services for lifetime cycle assessment of engineering materials will be provided. Figure 146.3 shows the remote safety assessment flowchart based on MatCloud platform.

The MatCloud platform responds for the requirements of the user. The user can obtain information from the experiment cloud, the simulation cloud, the data cloud and the monitoring data. And in order to improve the accuracy of safety assessment, the standard with the probability analysis tool, prediction analysis tool, the reliability analysis tool and the risk analysis tool, will be analyzed for safety assessment.

If the requirement is more complicated, the MatCloud would provide the remote safety assessment with the remote experts. And last, the user will get a comprehensive report for the requirement.

146.5.3 Future Work for MatCloud Platform

1. Centering on the different fields of advanced manufacturing engineering, gradually improve the MatCloud platform. For example, the gearbox is the important component of the high-speed train. We are going to develop a integrated database for reliability analysis and risk assessment of the gearbox based on the MatCloud platform.
2. For long-time assessment of engineering materials, we will establish a monitoring system based on the Internet of Things for pipelines or roads. And the monitoring data can be automatically integrated to the MatCloud platform.
3. Strengthen the cooperation with the research institutes and the manufactories of materials science and engineering. In this paper, we only propose the MatCloud platform framework of lifetime cycle assessment for engineering materials. And in the future, we and all possible users will focus on this work.

146.6 Conclusion

In this paper, we proposed a new cloud platform framework of lifetime cycle assessment for engineering materials.

1. The concept of materials cloud (MatCloud) is presented. The MatCloud platform is based on the requirement of materials science and cloud computing. By the MatCloud, we may overcome the limitation of the traditional materials databases.
2. The key technologies and the prospect of the MatCloud platform have been analysed detailed in this paper. And the platform will be gradually improved in the future.

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Chapter 147
Decisive Factors Influencing Establishment of Long-Term Mechanism of College-Enterprise Cooperation and Corresponding Counter-Measures

Shui-gen Zhu

Abstract As a national policy, the college-enterprise cooperation is the necessity for and inevitable choice of higher education reform. Whether the local colleges and enterprises can realize in-depth cooperation and form a long-term mechanism depend on policies formulated and efforts made for the establishment of cooperation platform, the building of innovation team, and the formulation of policies and systems. The platform for cooperation is the basis for the establishment of a long-term mechanism; the innovation team is the key factor because a stable team will guarantee the smooth establishment of the long-term mechanism. As the prerequisite, the sound policies and systems will fundamentally guarantee the successful completion of the cooperation platform and the building of innovation teams.

Keywords College-enterprise cooperation · Long-term mechanism · Cooperation platform · Policies and systems · Team building

147.1 Introduction

In the National Long-term Educational Reform and Development Plan (Ministry of education of China 2010–2020), the government has clearly required the combination of industry, teaching, research and application; stipulating regulations for the promotion of college-enterprise cooperation institutionalization. College-enterprise cooperation as a national policy is the necessity for and inevitable choice of higher education reform and development. The long-term mechanism of college-enterprise cooperation refers to the system that ensures the smooth operation and the desired functions of the cooperation for a long time to come. The

S. Zhu (✉)
Pinghu Campus, Jiaxing University, Zhejiang, China
e-mail: zhushuig@126.com

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core issue of the system here is the design and effect of policies and systems, with the basis being the status and tactics for the establishment of college-enterprise cooperation platform and innovation team. The smooth advancement of the establishment depends on the implementation of policies and systems.

College-enterprise cooperation is based on the cooperation platform, innovative team and corresponding policies and systems, the three of which being interdependent and mutually supporting each other with logic relationship (Zhao 2009; Fang et al. 2005). Without a solid platform for cooperation, there will be no basis for organization, environment and ways of working together; without a stable team, there will be no capability and benefit; without sound policies and systems, there will be no work orientation and guarantee. The author explores from three aspects the problems and countermeasures in the establishment of long-term mechanism based on practice.

147.2 Analysis and Countermeasures

147.2.1 Cooperation Platform is the Foundation for the Establishment of the Long-Term Mechanism

College-enterprise cooperation platform is the organization or agency, environment or conditions, approaches or methods required for the cooperation, such as institutes, technical R&D centers, studios, IT service system, training channels, etc. Close cooperation is based on such a platform which in turn constitutes the elementary conditions for cooperation. Different forms of college-enterprise cooperation platform have different modes and manners of college-enterprise cooperation, resulting in different cooperation mechanisms.

China has issued The Guidance for Promotion of the Establishment of Public Service Platform for SMES (China's State development and Reform Commission 2010) (hereinafter referred to as public service) for the promotion of public service platform establishment, the train of which can be adopted for the establishment of school-enterprise cooperation platform. Public service platform for SMES and school-enterprise cooperation platform have many significant differences in terms of the nature, the value from implementation, service object and methods of operation (Table 147.1).

Table 147.1 Comparative analysis

Type	Nature	Values	Target	Operation
Public service of enterprise	Legal entity	Focus on common needs	Serve enterprise	Market operation
College-enterprise cooperation	Non-legal Entity	Focus on special needs	Serve College enterprises	Non-Market Operation

The above table shows that, the school-enterprise cooperation platforms generally do not have legal status, and the market-oriented operation is also limited, so it is difficult to fully meet the common needs of the enterprises; on the other hand, it provides service not only to enterprises, but also to colleges and universities. One key factor for school enterprise cooperation is the improvement of ways and means of running the colleges and universities so as to improve the quality of their graduates. The institutional issues are the main obstacles for the establishment of school-enterprise cooperation platform. For instance, personnel training in school-enterprise cooperation can not be put into market operation and it is also impossible for such kind of operation.

Despite the differences of college-enterprise cooperation platforms established by different types of colleges and universities as well as enterprises with different needs, the suitability of the platforms as well as the service level and capability of the platforms must also be taken into consideration by all of the colleges and enterprises.

(1) Choosing the right platform in line with strategic development of college-enterprise cooperation.

From the mode or ways of college-enterprise cooperation, we have such domestic experience as: adopting share collaboration form of cooperation between colleges and enterprises to form stable and long-term partnership to provide organizational guarantee for cooperation (Xu 2010); establishing and improving the Council system, in which the colleges, the enterprises and the government work hand in hand (Hung 2010); drawing on the experience of dual system, which was initially proposed in German “dual system” of education in the late 19th century, and was later fully improved and reflected in cooperative education in Britain, U.S.A and other countries (Jin and Zhu 2005). Domestic scholars pay much attention to this mode. Establishing joint research institutions with colleges and universities through joint lab projects, for example, Microsoft, IBM, TCL, Haier and other domestic and foreign enterprises have conducted various kinds of cooperation with colleges and universities, of which “the joint lab projects” being the most stable, far-reaching and dramatic (Guan and Hu 2009); Establishing industry-university work-stations to explore innovative mode of college-enterprise cooperation mechanism based on the features of local businesses such as the size and distribution (Zhang et al. 2011). In addition, there are also some R&D centers established in the enterprises for the purpose of university research.

Due to the different modes or the different ways of cooperation, the different types of colleges and universities as well as the different needs of enterprises, there are no uniform standards and requirements for the establishment of college-enterprise cooperation platforms. Joint research institutions, industry-university work-stations, R&D centers, all have their respective service partners and demands. Currently, most colleges and universities vary greatly in terms of their relationship with enterprises; however, the cooperation platforms are mostly on the surface due to many reasons, such as system or policy issues. For example, a local college has reached a consensus with a local well-known enterprise to establish a close partnership, and has now completed the initial establishment of an apparel design and R&D center integrating project development, technological innovation, staff training and student training. What's more, clothing culture will also be incorporated. Nevertheless, due to institutional and policy reasons, the enterprise has been playing the dominant role in the cooperation, thus the service capabilities of the college are greatly limited. It is able to serve the enterprise, but difficult to meet the needs of other enterprises in the local area. And on the other hand, once the cooperation is terminated or suspended for this or that reason, the college has to look for other partners, which will affect the long-term cooperation mechanism. It is quite necessary to make adjustment to meet strategic needs of college-enterprise cooperation. In such cases, a cooperation platform should be established in accordance with the local situation that the local garment industry need to be upgraded and the colleges need to be transformed towards practical application.

(2) Adjust the platform establishment mode according to service capability.

To participate in the establishment of college-enterprise cooperation platform, the local colleges and universities can refer to the establishment of public service platform for SMES, that is to say, they should establish the cooperation platform based on their own professional and academic advantages. For example, in establishing Garment Industry Development Promotion Center, they should focus their service on garment enterprises in line with their capabilities. Through the college-enterprise cooperation platform, both parties can provide such services as information inquiry, technological innovation, quality inspection, regulations and standards, management consulting, business counseling, marketing, personnel training, equipment sharing, etc. However, as for the colleges and universities, they should know what to do and what not to do. Generally, colleges and universities are capable of such services as information inquiry, technological innovation (brand planning and design), management consulting, personnel training, research projects, equipment sharing. In this way, colleges and universities can help make smooth the information transmission channel for enterprises, help improve operation and management, help enhance quality of products, help increase market competitiveness, help realize innovation and fast development, thus playing the pivotal role in the process of cooperation. The taboo during the establishment of college-enterprise cooperation platform is to bite off more than one could swallow, and to mix up one's position and responsibilities.

147.2.2 A Stable Team for Cooperation is the Guarantee for Further Establishment of the Long-Term Mechanism

The biggest challenge for colleges and universities in college-enterprise cooperation is their comprehensive ability to serve enterprises(Wang et al. 2007), which is embodied in the cooperation team. So, team building is one of the most important factors in the cooperation between colleges and enterprises.

1. Problem analysis

The teams composing of people from both colleges and universities fall into three categories: research teams of colleges and universities, technology teams of enterprises and innovation teams from college-enterprise cooperation. These three types of teams have their own advantages and defects.

The research teams of colleges and universities have the advantages of talents, which need to be optimized and integrated in serving the enterprises. Some researchers gathered and analyzed the problems occurred during the establishment and management of research teams, and they are generally as follows: (1) the research orientations are much scattered without clear goals, the result of which is the difficulty of each orientation to achieve significant results; (2) personnel structure is not reasonable enough due to lack of high-level talents, so it is quite difficult to produce significant outcome; (3) there are very few high level and harmonious research teams, whereas low level scientific research teams can maintain only a short time, lacking in the building of team culture; (4) research management system is not up to standard, and management system is not reasonable, neither of which has promoted the development of the research team; (5) there is not a sound mechanism for the examination, appraisal and incentive of the research teams, lacking in effective supervision over the performance of the teams; (6) the transformation of scientific research results has been neglected, making it difficult to continue the research work (Hung 2010). The technology teams of enterprises are much skilled in transforming and upgrading technology, yet they have much limited capabilities in scientific research due to lack of profound and solid academic background and high-level academic talents. The innovation teams from college-enterprise cooperation can gather people focusing on scientific research and production technology, thus greatly optimizing and elevating the teams' service ability. However, the striking problem of innovation teams in college-enterprise cooperation lies in the fact that it will take a fairly long time for the integration of the teams due to differences in terms of systems and cultures between schools and businesses. Moreover, from the overall situation of domestic college-enterprise cooperation and innovation teams, the most prominent problem is: the team structure is irrational, the lack of high-level talents; the overall level of the teams is not high, the service capacity is not strong; since there is a lack of policy guarantee, the capacity for sustainable development is much limited.

2. Discussion of countermeasures

Compared with the establishment of research teams in general, the innovative teams of school-enterprise cooperation put more emphasis on applied research and transformation of scientific research results; therefore, technological innovation is the key factor. In one word, innovative teams in school-enterprise cooperation should pay more attention to practical service capabilities and sustainable development capacity.

(1) Integration and optimization of innovation teams of college-enterprise cooperation.

Currently, of the large number of local colleges and universities, only a very small number of them are capable of organizing school-enterprise innovation teams. In general, these teams will not be fully capable of providing services to enterprises until after they have been re-organized based on college-enterprise cooperation strategies.

There are two comparatively realistic approaches for the integration and optimization of the innovation teams of school-enterprise cooperation. Firstly, appropriately configure corporate technological resources based on college research teams, so as to integrate and optimize innovation teams of school-enterprise cooperation. These teams will not only have a strong capacity for scientific research, but also can produce effective scientific research results and promote technological innovation and upgrade; they can not only meet the needs of enterprises, but can also satisfy the requirements of education reform of colleges and universities. Secondly, appropriately allocate scientific research resources of colleges and universities based on technological teams of enterprises, so as constitute school-enterprise innovation team through integration and optimization (Wang et al. 2010). Such teams are generally suitable for growing businesses. Since growing businesses usually have their own technological strength, therefore, so long as there are certain high-level talents of scientific research, the colleges and enterprises can establish effective and productive innovation teams. These teams are much likely to play a larger role in corporate transformation and elevation as well as brand building.

No matter what forms the teams may assume, they should learn to complement and integrate with each other, so that they can make concerted efforts to better serve the cause of colleges and enterprises. Therefore, we should first of all, take into account the practical needs of the industry and the enterprises cooperating with colleges, to select those talents who are loyal, professional with expertise, and who are fully able to solve practical problems for the formation of teams. This is to ensure that during the initial period of school-enterprise cooperation, there are people who are not only willing but also capable to do a great job. Secondly, policies and systems should be drafted afterwards to resolve the conflicts and contradictions that may arise between the team members in the process of team building. Since the innovation teams of school-enterprise cooperation are composed of talents from different departments of the colleges and enterprises for the purpose of integrating service capabilities, the team organization is not yet stable enough without the team culture, so the operation of the teams depends to a large extent on profit and the corresponding systems. The intervention of systems will enable the teams to: (1) be clear about their responsibilities and work diligently; (2) pay much attention to communication and unity in cooperation; (3) reasonably distribute benefits to establish correct values and outlook on life.

(2) Establishment and Training of innovation teams of school-enterprise cooperation.

Since service capabilities of the teams depend on the overall quality of the teams themselves, so we should pay attention to the establishment and training of ideal teams. The internal organizational structure of an excellent team must be unique in terms of its qualities (Ren and Wang 2011). Meredith Belbin, the former director of Cambridge Industry Training Research Department, found that team members of the top performing companies have differences in their intelligence. The ideal team model is consisted of a talented person with ideas, a smart member, a leader with IQ slightly higher than the general level, and other members with intellectual being slightly below the general level (Successful combination of talent on the team 2009). According to this theory, the team members should be carefully selected and appointed during the initial period of the establishment of an ideal team. We learn from past experience that the born defects of the teams during the initial period of the establishment are always fatal to the fate of the teams, so efforts should always be made to provide training for the establishment of ideal teams. That is to say, it takes time to establish ideal teams, so we should try to make up for the born deficiencies for the purpose of building the reasonable and sound internal structure of the teams in the process of operation.

Even a team is born an ideal one, continuous efforts should still be made to overcome obstacles occurred during cooperation between colleges and enterprises (Deng 2011). Team building must be carried out based on external factors and internal factors. External factors—from the manager perspective, refer to policy, platform, personnel, funding, and basic conditions which must be satisfied to certain extent according to team building needs. On the one hand, these conditions cannot be met by the teams themselves, and on the other hand, the teams should not neglect and look down upon these conditions. Internal factors-from a team perspective, refer to competition for projects, achievements, profit, service, self-development, etc., which are the basic activities of the teams themselves. During the combination of industry, teaching and research, projects and outcomes are the core issue, benefits and services are the fundamental problem, and self-improvement towards further development is a prerequisite for sustainable development of the teams.

Studies have shown that a team that can really promote scientific and technological progress should be characteristic of sustainable and harmonious development. A sustainable and harmonious research team system should consist of such elements as: reasonable goals for building a research team; reasonable organization and allocation of responsibilities; basic guarantee conditions such as researchers, funding, and research platform; timely research team operation, supervision, management and internal communication; appropriate examination, appraisal and incentive-granting measures for the research teams (Zhang et al. 2011). Thus, the management system of a team should be established from the external factors and internal factors, so as to ensure harmonious and sustainable development of the team.

147.2.3 Sound Policies and Systems are the Fundamental Guarantee for the Establishment of Cooperation Platform and the Building of Innovation Teams

Policies, which play the role of guidance guarantee, are the core factors for the establishment of college-enterprise long-term mechanism, and also the prerequisite for in-depth cooperation between the two parties.

1. Problem analysis

College-enterprise cooperation is a relationship of interest in essence. Since balanced or maximized interest can not be always maintained during school-enterprise cooperation, so crisis will arise at any time. During the cooperation between colleges and enterprises, difficulties will occur if there is no sound mechanism for dealing with crisis or there is an absence of such a mechanism, or that the contradictions between the two sides of cooperation can not be resolved, or that the prevarication that prevents the cooperation from being carried out further can not be resolved in a timely manner. Currently, it is a quite common phenomenon that there is only a cooperation agreement and no supporting policies in college-enterprise cooperation, the fundamental reason of which is the absence of government as the dominant or promoter in school-enterprise cooperation. Without the involvement or dominance of government department, embarrassed situations in cooperation are much likely to occur, or that the cooperation is even suspended halfway due to the inability of both parties to solve some problems.

2. Discussion of countermeasures

The continuous needs of both colleges and enterprises are the driving force of the innovation of college-enterprise cooperation long-term mechanism. So long as the cooperation platform and the relationship between the two parties of cooperation are developing constantly, and so long as new projects of cooperation are always renovating themselves, there will always be innovation in college-enterprise cooperation mechanism. Without the needs, there will be no requirements for continuous innovation in the cooperation mechanism. In other words, without the innovative strategy of long-term mechanism of school-enterprise cooperation, the continuous development of the cooperation platform and the continuous renovation of new cooperation projects will be hindered due to the absence of system and mechanism. The role of policies is to guide and guarantee that the needs will be satisfied and at the same time there will always be new needs.

(1) Constitute policies and systems based on the common interests of both colleges and enterprises.

The fundamental issue of school-enterprise cooperation is the satisfaction of the interests of both parties, on the premise that both parties should fully respect for and pay attention to the interests of the other side and benefit each other. Therefore, in constituting policies, the interests of both parties of cooperation should be clearly defined. For example, in a school-enterprise cooperation agreement, the interest needs of both parties are stipulated as follows:

Both parties of cooperation should fully respect and pay attention to the interests of each other.

The interests of Party A: With the platform of "××× international clothing research and development center": (1) implement the clothing brand building strategy; (2) promote transformation and upgrading of the enterprise; (3) upgrade corporate economic competitiveness and bargaining capacity for products; (4) regulate staff training; (5) promote corporate cultural value innovation to further increase corporate social reputation.

The interests of Party B: With the platform of ××× international clothing research and development center: (1) integrate into national technological innovation system, and implement national strategy of school-enterprise cooperation, to reflect the will of the state for higher education; (2) expand and innovate means and approaches for the running of colleges and universities to promote the reform of higher education, to effectively develop socially useful talents with applied expertise; (3) take advantage of the combination of industry, teaching and research to consummate personnel training, improve practical training of students, and provide "dual certificates" training to teaching staff; (4) consummate academic organizations at the grass-roots level to promote applied scientific research; (5) provide social training and cultural establishment services to enhance the ability of social services.

On the basis of interest needs, we should constitute policies that can play the role of guidance and guarantee, so that we can stipulate the invested human and financial resources, deploy work and projects, and divide power and responsibilities.

(2) Constitute policies and systems based on a clear understanding of service functions within the field of cooperation.

In college-enterprise cooperation, there must be systems to clearly define and regulate such aspects as personnel (who provides and trains), money (who inputs), resources (how to develop and utilize), platform (how to build), projects (what project to be research, who will undertake), responsibility (how to divide and undertake).

There will be a wide range of systems in college-enterprise cooperation, that is to say, the systems are designed to solve the possible problems and to protect the mutual interests of both parties. Therefore, different systems have different requirements. Since there are extraordinarily emphasized service functions and less emphasized service functions in college-enterprise cooperation, so it is quite necessary to make a clear line between the two types. For the convenience of discussion, the author, based on his practical experience, divides the school-enterprise cooperation into a variety of service functions, including the function of educational service and the function of scientific and technological service. The function of educational service of school-enterprise cooperation is to provide schools with education reform services, to provide opportunities for teachers to assume certain posts in enterprises, and to participate in project development. As for students, the function of educational service is to provide students with the access of practical internship or training services. The corresponding policies include personnel training and introduction of talents, practicing and training system, cultivating innovative teams and constituting systems. The functions of scientific and technological service of college-enterprise cooperation include information inquiry, product development, training in new technologies, brand-cultural training for staff, equipment sharing services, etc… What's more, corresponding policies and systems should also be stipulated and clearly defined according to the specific needs.

In addition, since college-enterprise cooperation involves many aspects and issues (Wu 2011), so a hierarchical classification should be made in constituting the systems, with some points being highlighted and the overall situation being considered. Only in this way can we form relatively perfect systems. At the same time, a timely evaluation of the implementation and operation of the system should also be made, so as to gradually form a mechanism for evaluation and improvement of the systems. Thus, the systems, which can remain vitalized as the result of continuous innovation, will lead the college-enterprise cooperation to develop healthily.

147.3 Summary

The in-depth cooperation between colleges and enterprises is a systematic project that can not merely rely on the cooperative projects or technological service cooperation between the two parties. So, in establishing systems, we should note that: needs of enterprises should be fully considered in personnel training of colleges; school culture should match corporate culture; school development should match corporate strategy. In other words, the in-depth college-enterprise cooperation is an integration of college-enterprise culture. Only in this way can we ensure that those engaged in education and those engaged in business would have common faith and spiritual pursuit. And finally, the author reminds that the cooperation between colleges and enterprises should by no means be seen as a deal like that in the grocery market.

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Chapter 148
The Regional Emerging Strategic Marine Industries Evaluation: A Case of Tianjin Binhai New Area

Jian Li and Ying Wang

Abstract Development of strategic marine industries is China's "12th Five-Year" period vigorously implement marine development strategy, it is the development direction of China's marine economy, therefore the proper selection and development of strategic marine industries is great significance. This paper based on the analytic hierarchy process and fuzzy evaluation method evaluation weather suitable for the development of strategic marine industries in Tianjin Binhai New Area and had an empirical research to the comprehensive utilization of seawater industry. To draw the comprehensive utilization of seawater industry rating of 84.6868. Concluded that Tianjin suitable for the development of seawater utilization industry as a strategic emerging industry.

Keywords AHP · Binhai new area · Emerging industries of strategic marine · Industry evaluation

148.1 Introduction

In recent years, China vigorously promote marine development strategy,The marine economy developed rapidly and made great achievements. In 2010, China's marine industry overall to maintain steady growth. Among them, the major marine industry was 1.5531 billion yuan, up 13.1 % over the previous year; Marine scientific research education management service was 683.9 billion yuan, up 10.7 % over the previous year. Offshore oil and gas industry was 2.8 billion

J. Li (✉) · Y. Wang
School of Management, Tianjin University of Technology,
Tianjin, China
e-mail: lijian631219@163.com

Y. Wang
e-mail: wangying_886@126.com

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yuan, up 30.1 % over the previous year. Marine bio-pharmaceutical industry was 6.7 billion yuan, up 25.0 % over the previous year. Marine shipbuilding industry was 118.2 billion yuan, up 19.5 % over the previous year. The development of marine economy is much faster than the growth rate of the national economy so the development of marine economy has become a global strategic choice, The Ocean will also become the main battlefield of China's Strategic emerging industries. China Ocean Development Report pointed out in the "12 Five-Year" period, China will be initially formed the marine industries system, priority support Marine engineering equipment manufacturing, Marine biological products, ocean health farming, Polar marine living resources development and utilization, Utilization of seawater, New marine energy and Modern marine services and made these High-tech achievements industrialization which drive the traditional marine economy pillar industry in technological upgrading and develop the regional economic.

148.2 Emerging Strategic Marine Industries

U.S. economist A.O.Hirschman first proposed the concept of strategic industries, he call the economic system which has the most closest associated with input–output relations (Hirschman 1991). Zhao Yulin see Emerging industries as a sunrise industry (Zhao 2004; Zhao and Zhang 2007).Chen gang think Emerging industries take on new social production division and have certain size and influence, Represents a new requirements of the market economic system overall output and a new direction for the industrial structure transformation also represents a new level of new science and technology industrialization, and it Is in the formative stages of the life cycle (Chen 2004). Jiang Shiyin pointed out strategic industries is the key, global and long-term industry which related to national economic development and regional strategic rationalization of industrial structure (Shiyin 2005). Xiang Xiaomei pointed out Regional strategic industry means to which can reflect regional economic development strategy needs and adapt to medium-and long-term demand structure change trends and represent the future direction of economic development and direction of technological progress and support economic growth and have a significant impact and a leading role to the regional economic development. These industries have the characteristics. Of high growth, high relevance, high permeability, high innovative and high-strategic (Xiaomei 2006). Zhou fei, Wang ning pointed out that the emerging strategic industries is a breakthrough after the traditional industries, either can play a supporting role on the current industrial structure adjustment or can lead the green development of the socio-economic, Gradually become the leading force of economic and social development (Zhou and Wang 2010).The economic impact of the marine economy is poorly understood at both national and regional levels in Ireland (Morrissey and O'Donoghue 2012). Colombia's marine fisheries are limited by the relatively small size of commercially important stocks (Wielgus et al. 2010).

148.3 The Choice of Emerging Strategic Marine Industries

"Strategy emerging" Consider the industry of choice to meet the principle of strategic emerging. The emerging strategic industries have a group of related and supporting industries, including the opportunity bring by traditional industries and new industries and involves the degree of industrial relevance. Second is the leading, they are the direction guide for national economic development, Represents the direction of technology development and the evolution of industrial structures (Zhao 2010). The choice of strategic industries must seriously consider whether the selected industry bring many jobs. Finally, selected industries must take into account the global economic development, including the optimization of industrial economic structure, Led economic development (He et al. 2010). Select strategic marine industries either consider the above factors or consider whether the industry can bring social and environmental benefits to achieve the sustainable development of marine economy.

Strategic marine industries choice is a relatively vague concept, generally difficult to precise positioning, so this paper takes the AHP and fuzzy evaluation method for the quantification of qualitative issues.

This paper from the government support, the degree of environmental pollution, resources environment, market demand, technology research, strategic emerging six indicators begin to choose the strategic marine industries (Fig. 148. 1).

148.4 The Evaluation of Tianjin Emerging Strategic Marine Industries

This paper from the Tianjin to the development of Emerging strategic marine industries may bring benefit point of view, objective scientific analysis of the marine industry of Binhai New Area, Specific indicators of the evaluation method is to invite the authority of experts to make an objective evaluation of the actual situation and the various types of statistics and according to personal views.

Binhai New Area according to its industry and location advantages focus on the development of marine fisheries, offshore oil and gas industry, marine chemical industry, coastal tourism, marine transportation, marine engineering construction, Which initially identified the development of seawater utilization industry, marine high-end equipment manufacturing, marine engineering, construction, marine renewable energy industry and the marine biopharmaceutical as Emerging strategic and emerging industries. Analysis to see whether it can develop the preliminarily determined emphasis develops industry. Below take the Seawater utilization industry for example (Table 148.1).

Using AHP software to calculate CR = 0.090, According to evaluation and analysis sorted the second indicators of fuzzy evaluation matrix as shown in Table 148.2.

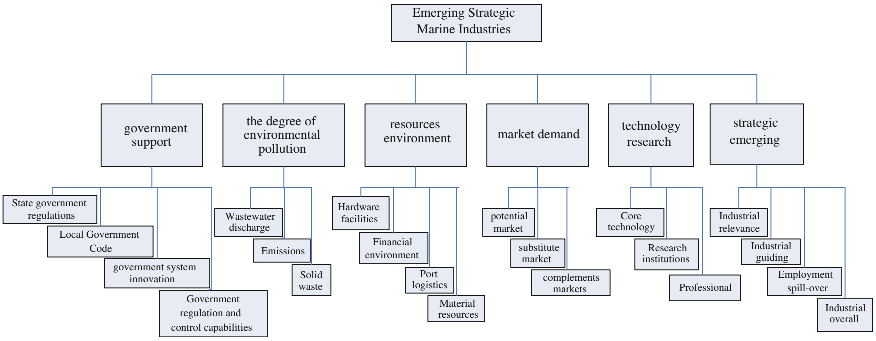

Fig. 148.1 Emerging strategic marine industries evaluation index system

Calculate out the weight coefficient $W_{1j} = (0.551, 0.265, 0.089, 0.095)$, calculate the membership degree vector of the comprehensive evaluation, $J_1 = W_{1j} \cdot R_1 = (0.7087,\ 0.264,\ 0.0273,\ 0)$ $J_2 = (0.6212, 0.2997, 0.1224,\ 0)$ $J_3 = (0.447, 0.384, 0, 1524, 0.081) J_4 = (0.3971, 0.254, 0.2703, 0.0786)$ $J_5 = (0.1516, 0.1542, 0.1488, 0.0594)$

$$J_6 = (0.4, 0.3087, 0.2, 0.0913)$$

Calculate the comprehensive evaluation membership matrix of the marine biopharmaceutical industry A: obtained $\bar{A} = (0.5248,\ 0.2897,\ 0.1255,\ 0.03752)$, $\mathrm{V} = (100, 80, 60, 40)^{\mathrm{T}}.\mathrm{C} = \bar{A} \cdot V = 84.6868$.

148.5 Conclusions and Recommendations

The oceans are in trouble(Kildow and McIlgorm 2010),Tianjin in the development of marine economy at the same time emphasis on sustainable development, save resources and reduce energy and protect the environment to achieve a sea of harmonious development(Fu et al. 2010). Fine sea management, lead to introduce the use of sea-standard system in the country, to retain the waters and shoreline resources, and leave space for future development. Strengthen environmental

Table 148.1 Level indicators judgement matrix

U	u_1	u_2	u_3	u_4	u_5	u_6	Weights W_i
u_1	1	2/5	2/5	2/3	3/5	2/3	0.280
u_2	5/2	1	1	3/2	2	3/2	0.238
u_3	5/2	1	1	3/2	2	3/2	0.212
u_4	3/2	3/2	2/3	1	5/4	1	0.102
u_5	5/3	1/2	1/2	4/5	1	4/5	0.097
u_6	3/2	2/3	2/3	1	5/4	1	0.072

Table 148.2 Comprehensive fuzzy evaluation matrixes of the second in indicators

Level indicators W_i	Second indicators U_i	Evaluation matrix R			
		Excellent	Good	Middle	Poor
Government support u_1	State government regulations u_{11}	0.7	0.3	0	0
	Local Government Code u_{12}	0.8	0.2	0	0
	Government system innovation u_{13}	0.5	0.3	0.2	0
	Government regulation and control capabilities u_{14}	0.7	0.2	0.1	0
The degree of environmental pollution u_2	Wastewater discharge u_{21}	0.6	0.3	0.2	0
	Emissions u_{22}	0.7	0.3	0	0
	Solid waste u_{23}	0.5	0.3	0.2	0
Resources environment u_3	Hardware facilities u_{31}	0.4	0.4	0.2	0
	Financial environment u_{32}	0.6	0.4	0	0
	Port logistics u_{33}	0.4	0.3	0.2	0.1
	Material resources u_{34}	0.4	0.4	0.2	0
Market demand u_4	Potential market u_{41}	0.4	0.3	0.3	0
	Substitute market u_{42}	0.5	0.2	0.2	0.1
	Complements markets u_{43}	0.2	0.2	0.3	0.3
Technology research u_5	Core technology u_{51}	0.5	0.3	0.2	0
	Research institutions u_{52}	0.2	0.3	0.3	0.2
	Professional u_{53}	0.4	0.3	0.3	0
Strategic emerging u_6	Industrial relevance u_{61}	0.4	0.3	0.2	0.1
	Industrial guiding u_{62}	0.4	0.3	0.2	0.1
	Employment spill-over u_{63}	0.4	0.3	0.2	0.1
	Industrial overall u_{64}	0.4	0.4	0.2	0

protection, strict control of pollutants into the sea, Focus on ecological restoration, to carry out comprehensive marine remediation and artificial reproduction and releasing. Positive election of special marine protected areas, and vigorously develop the circular economy, rational use of marine resources.

This paper explores the development of emerging strategic marine industries in Tianjin. At the support of the national "12th Five-Year" Planning Policy, according to the maritime economy and social conditions as well as local policies, valuate and score to may develop into the emerging strategic marine industries. Make the macro and micro conditions of the region to the qualitative and quantitative, to reduce the subjectivity of the person to make the evaluation more objective and scientific. According to conditions of Tianjin development of emerging strategic marine industries we can conclude that focus on developing of seawater utilization industry is feasible.

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Chapter 149
Study on the Relationship Between Familiness and Performace of Family Business

Yan-shuang Li and Yong Wang

Abstract This article analyzes the structure of familiness and the evaluation indicators of family business performance. Familiness is constructed by family ownership, family blood thickness, and family member CEO; Family business performance is divided into two aspects: wealth creation and value creation. Three propositions are postulated about the relationship between familiness and performance. The conceptual exploration of the structure of familiness, the evaluation of performance, and the relationship between familiness and performance may offer a unique perspective in the research domain, future studies may work towards validating the propositions put forward in this study.

Keywords Familiness · Performance · Family business · Blood thickness · Family ownership

149.1 Introduction

Nowdays, family business continue to be the important part of the worldwide economy, no matter in western or eastern countries. Some researchers present that many family business usually have much better performance than their non-family competitors because of the family involvement.

Family business has some different features comparing with the non-famliy business. Such as the family ownership of the family business, the unique governance of the family business, the management style and the sustainable vision of

Y. Li (✉)
School of Management, Hebei University of Technology, Tianjin, China
e-mail: lilicathy@163.com

Y. Wang
Wolverhampton Business School, University of Wolverhampton, Wolverhampton, UK

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the family business. Some scholars presented that family business can be seen as the combination system of three subsystems, that is family roles subsystem, family business ownership subsystem, and family business activities subsystem, there are "blurring" boundaries among the three subsystems, and usually if a business embodies the three subsystems or at least two of them, we can pronounce that the business is a family business.

With regard to the question how to judge that a business is a family business or what degree is the family involvement in a family business, some scholars introduced the term 'familiness'. The term 'familiness' was used to express the interaction relationship between the family, the business, and business management. The authors who first presented the term of 'familiness' are Habbershon and Williams, in their paper, they defined the term of familiness as the unique bundle of all of the family business resources, and particularly, they think that the bundle of resources come from the interaction relationship among the business, the family, and the family members. Since then, many scholars have made efforts on understanding the factors of family involvement in the family business, the essence of the family involvement, and consequently, the resulted performance of the family business (Chrisman et al. 2005).

The purpose of the present research is to discuss the relationship between the familiness and the family business performance. Based on the literature review about the factors and structure of the familiness and the evaluation construction of family business performance, a series of propositions is presented, and suggestions are made for ongoing research.

149.2 Structure of Familiness

Generally speaking, "familiness" is often used as a mean to explain the interaction of various resources within family business, or as a method to distinguish between non-family and family businesses. Till now, many scholars prefer to explaining familiness as the combination of existing stocks of various resources in the family business, such as the human resource, the social resource, the financial resource, and the physical capital resources, while the combination of the various resources is resulted from the interactions relationship between family and business subsystems (Sharma 2008). In order to evaluate the effect of family involvement, Matthew, Donald and Daniel used the definition of "high familness" and "low familiness" to express the degree of family involvement, or the 'familiness' degree.

Astrachan et al. firstly presented the F-PEC model for measuring the familiness of family firms, some scholars tested that it is useful. In the F-PEC model, F replaces family, P replaces power, includes 2 items: (1) how many ownership/ownership percentage is shared by family members; (2) how many family members are on the family business's governance board; E replaces experience, includes 3 items: (1) which family generation is owning the family business; (2) which family generation is managing the family business; (3) which family generation is acting on the governance board; C replaces culture, includes 7 items: loyalty, pride, and so on.

In our study, in order to present some propositions for the empirical research, we mainly consider the familiness from three measurable dimensions: (1) family ownership, it refers to the number of family members that share the family business ownership, the generation of the family members that is owning the company, the overall and individual ownership percentage of the family members; (2) family blood thickness, it refers to the numbers of family members that are on the family business's governance board and the relative blood thickness among the family members; (3) family member CEO, it refers to the family member who is acting on the family business governance board and is managing the company as CEO.

149.3 Evaluation of Family Business Performance

Traditionally, family business' performance is evaluated by financial indicators, generally include sales/revenue, sales/revenue per employee, debt-to-equity, and growth. Sindhuja (Sindhuja 2009) evaluated performance under four dimensions: (1) Value Creation: it is mainly measured by the Tobin's Q Ratio; (2) Growth: it is mainly measured by Compound Annual Growth Rate; (3) Profitability: it can be measured by ROA (Return on Assets), RON (Return on Net Worth), Return on Capital Employed, Profit Margin, Sales Turnover, Earning Per Share, Market Capitalization, and Net Operating Profit After Tax; (4) Risk: it is mainly measured by Debt-to-Equity ratio and Net asset (Sindhuja 2009).

Jim Lee (2004) divided family business performance into three aspects: profitability, operational efficiency, and financial soundness (Lee 2004). The profitability can be measured by net profit margin, gross profit margin, return on assets, return on equity, and return on invested capital. The operational efficiency can be measured by the turnover of inventory, the days of sales outstanding, days cost of inventory goods sold, turnover of asset, and net receivables turnover flow. The financial soundness can be measured by revenue growth in the last 12 months and in the last three years, the net income growth in the last 12 months and in the last three years.

A number of academic researchers have argued that accounting measures seem to be inadequate to indicate the true performance of the family business. Jira Yammeesri and Sudhir C. Lodh selected the datas between 1998 and 2000 on the Stock Exchange of Thailand to analyze, they utilized both market returns and accounting measures (profitability) as alternative proxies for family business performance.

In order to successfully transfer the family business to descendant generations, the family business usually pays attention to both economic and noneconomic results. Habbershon et al. explained that the familiness of a family business will lead to the family business' competitive advantage, and then the competitive advantage will enhance family business' wealth creation or economic performance. Chrisman et al. (2005) suggested that the familiness degree of the family business will also lead to family business' value creation or non-economic performance, such as the preservation of family blood ties or the value sustained across generations.

Chrisman et al. (2005) proposed that in order to evaluate the family business performance, both the economic and noneconomic benefits must be taken into account. In our paper, the family business performance is divided into two categories: wealth creation and value creation. Wealth creation refers to the economic outcomes, includes both market returns and accounting measures; value creation refers to the noneconomic outcomes, includes the loyalty, integrity, commitment, harmony, social status, reputation of the family business.

149.4 Propositions About the Relationship Between Familiness and Family Business Performance

149.4.1 Family Ownership and Family Business Performance

Ownership structure of a family business is clearly important in determining the family business' goals, the shareholders' wealth as well as how managers of a family business can be disciplined (Jensen 2000). Some researchers suggest that family businesses display significantly better market and accounting performance than their non-family counterparts. Maury (2005) tests the relationship by a sample of European family business and gets nearly the same conclusion, the result shows that family business exhibits better financial and economic performance than the non-family business (Maury 2005).

Thomsen and Pedersen investigated businesses' financial indicators of 12 European nations, they choosed three financial indicators: return on assets, market-to-book value, and sales growth. The 12 nations are United Kingdom, Germany, France, Italy, Spain, Austria, Belgium, Denmark, Finland, Netherlands, Norway, and Sweden. Their study suggested that in relation to market-to-book value and return on assets, family ownership exhibited a negative relationship compared to institutional investors. Whilst in sales growth regression, the result showed that sale growth was significantly higher in businesses with family ownership.

Jira Yammeesri and Sudhir C. Lodh examined the relationship between family ownership and business performance in Thailand, they calculated some businesses' data between 1998 and 2000, their results showed that business controlled by family was positively significant on the performance of profitability, but it was less significant to the performance of market returns. Barontini and Caprio (2006) summarized that family control is positive on valuation and operating performance for the continental European corporations (Barontini and Caprio 2006). Based on the above discussion, we present the following proposition:

Proposition 1: family ownership is positively related to the family business performance;

149.4.2 Blood Thickness of Family Members and Family Business Performance

Venter introduced the concepts of founder-capital, family-capital and generation-capital in familiness transmission of capital model. Founder-capital considers the founder of the family business as a resource, family-capital considers founder's children as a resource, whilst generational-capital considers the descendants of the siblings in the family business as a resource. Venter indicated that once the founder retires or leaves the family business because of other reasons, the founder-legacy will be inherited by descendants, and the founder-legacy will be internalized and absorbed within the family business, then the founder-legacy will continue to influence the next generations of the family business.

Nicholson (2008) found that human action will exhibit obvious differences when humans act towards relatives and act towards the person they do not familiar with (Nicholson 2008). Generally, humans act much enthusiastic to their close individuals, i.e., siblings in family business. Neyer and Lang expressed the thickness of the family governance board as factor r, which stands for the genetic relatedness between the family members. To monozygotic twins, they defined the value of r is 1, since they share all the genes; to parent, child, dizygotic twins, and full sibling, they defined the value of r 0.5; to grandparent, grandchild, half-sibling, and avuncular relationship, they defined the value of r 0.25; to cousins, great-grandparents, great-grandchildren, great-uncles, and great-aunts, they defined the value of r 0.125; and to other kin, they defined r 0.0625, and so on. Collin et al. (2011) had presented a term of family coefficient, which stands for the sum of all r factors on the governance board of the family business, it can replace the blood thickness of the governance board, and can be seen as the overall indicator of familiness (Collin et al. 2011). The sum value of r can express the total degree of familiness. Collin (2008) presented that the governance board of a business has four functions, namely resource, decision, control, and conflict (Collin 2008). Collin et al. (2011) thought that the board orientation towards the four functions will be influenced by the total degree of the blood thickness on the board, and subsequently, the overall activity of the board will also be influenced. Based on the above discussion, we postulate the following Proposition:

Proposition 2: blood thickness in family business is positively related to the family business performance;

149.4.3 Management Position and Family Business Performance

Morcketal presented that founder CEOs are very important to the family businesses, they usually have the capabilities and incentive to innovate in the family business, and they are willing to invite the expertise to help enhance the value of the family business. Anderson and Reeb (2003a) examined the effect of family ownership on large publicly traded U.S. family businesses' performance, they found that the family business with family member CEOs displays a positive relation to economic performance. Where family member CEOs means the CEOs are founders of the family business or the CEOs are the descendants of founders in the family business (Anderson and Reeb 2003b).

Indicating from a study of 500 S&P (Standard and Poors) USA businesses, Anderson and Reeb (2003b) got the conclusion that when the Chief Executive Officers are the founders or other family members of the family businesses, the family businesses are more likely to have better performance, they will outperform their non-family competitors. Hence, we posit the following Proposition:

Proposition 3: family member CEO is positively related to the family business performance;

149.5 Conclusion

This study discusses the relationship between familiness and family business performance. The paper has two fold implication. First, presenting the indicators of familiness, which will facilitate the research domain in the familiness constuction. Second, considering both construction indicators of familiness and famiy business performance may not only encourage empirical studies between familiness and performance, but also drive researchers in the area to develop theories specific to the domain.

Following this conceptual exploration, future studies may work towards validating the propositions put forward in this study. Along this direction, a number of research initiatives could be contemplated. First, more detailed constructs to measure familiness and performance is to be developed. In the paper, we mainly discuss the measurable indicators, how to definite and measure the qualititative indicators, such as the culture feature of familiness and the noneconomic outcome is still need effort. Second, qualitative/quantitative studies may be followed to enrich the understanding of familiness influence and validate the propositions proposed. Third, the majority studies of previous efforts that examine the relationship between familiness and family business performance have been conducted as cases in the western developed countries, such as the United Kingdom and the United States, for which its familiness structure is typically different to that of the cases in developing countries. Hence, the empirical studies in the developing countries are highly expected.

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Chapter 150
Advisers Troop Construction in Working-Practice in Collaboration Education Between Universities and Enterprises

Peng-hui Zhang, Hua-li Yu, Juan Wang and Xiao-shun Zhao

Abstract The wording-practice is a new attempt in practice teaching in the new model of collaboration education between universities and enterprises. A survey to internship students in our college and employees in enterprise objectively and quantitatively reflects that wording-practice is a successful model. Also it shows that problems exist in the wording-practice. This paper investigates the role and necessity of advisers in wording-practice, puts forward the construction of "double competency" teaching staff and establishment of a "double- mentoring", "three-dimensional" advisers. It provides successful experience for China's new pattern of collaboration education between universities and enterprises to build a bridge between colleges and enterprises and create a harmonious atmosphere.

Keywords Collaboration between universities and enterprises · Working-practice · Advisers

150.1 Introduction

The internship is an attempt in new practice teaching in the model of collaboration education between universities and enterprises for the purpose of developing students' overall quality and professional skills, and making students accept vocational training in actual working environment. Internship enables students to fully understand the need to learn theoretical knowledge as well as their own

P. Zhang (✉)
Pesonnel Division, Agriculture University of Hebei, Baoding, China
e-mail: Zhangpenghui866@126.com

H. Yu · J. Wang · X. Zhao
College of Mechanical and Electrical Engineering, Agriculture University of Hebei, Baoding, China
e-mail: zxs@hebau.edu.cn; zhao_xsh@126.com

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shortcomings in the knowledge. It encourages students to increase interest and motivation in learning, to extend practical knowledge and to improve the quality of learning. Also, it improves students' ability to integrate theory with practice, their work skills, professionalism and ability of social work.

At the same time, it enables enterprises to shorten training time and save training costs in order to obtain high-quality and highly skilled personnel, achieving college, students, enterprise, the three-way win-win (Shiwei 2010; Zhao et al. 2011).

However, collaboration education between universities and enterprises internship in China is not mature. How do internship students transit smoothly from college lives to the rhythm of business? How to maximize the combination of theory and practice? How to improve students' professionalism and ability of social work in a limited period of time? These are common problems we face. This paper investigates the importance of advisers' construction in collaboration education between universities and enterprises according to internship in our college. On one hand, advisers can go deep into the production practices in enterprises and communicate with engineering and technical personnel who have abundant practice experience to learn and improve practical ability. They should train excellent practical skills, enrich practical experience, update their professional knowledge and improve their professional skills so that their knowledge is always in the forefront of the industry. Realizing industry-university integration and school teachers spontaneously adjust the reasonable knowledge structure, reduce the cost of continuing education of teachers and lay a solid foundation for students' whole education and adaptive education. On the other hand, enterprises have advanced construction facilities, new leading technology in industry, a wealth of management experience and a certain corporate culture. Engineering and technical personnel with extensive practical experience can change the role to add to the teaching force through training. It is a prerequisite for the reform and development of vocational education to build a perfect adviser contingent (Chen 2010).

150.2 The Success of Internship in Collaboration Education Between Universities and Enterprises of Our College

According to a survey to internship students and enterprises, objective and quantitative data results show that the internship was very successful. The questionnaire is divided into student survey questionnaire and enterprise survey questionnaire. Respondents are all the internship students and group leaders in business production sectors. Among 315 student questionnaires 306 were returned and there are 303 valid questionnaires, and the effective ratio is 96.19 %. Among 120 enterprise questionnaires 116 were returned in which 111 are valid questionnaires and the effective ratio is 92.50 %. Questionnaire results are as follows:

150.2.1 The Analysis of Student Questionnaires

(1) In the understanding of internship, more than 70 % of students believe that they improve their interpersonal skills (86.8 %) and accumulate social experience(73.27 %); 79.21 % of the students think that internship helps to enhance their understanding of corporate culture; 92.83 % of the students believe that internships are important and worthy; 76.24 % of the students express satisfaction with the arrangements for the internship; 23.10 % of the students are willing to go to internships to work after graduation.

(2) Through practical exercises, the enthusiasm of the students have been generally improved. 83.17 % of the students think they need to increase the professional skills; 65.35 % think they need to increase professional knowledge; 52.81 % think they need to strengthen the basis of professional knowledge.

(3) Internship has great impact on students' opinion and attitude towards employment. 90.43 % of the students believe that internships are helpful to their future employment; 80.20 % of the students, through internships, change point of view in employment, and their employment goals are more pragmatic; 93.06 % of the students have started their planning for future career development after internship.

150.2.2 The Analysis of Enterprise Questionnaires

(1) Concerning the knowledge quality evaluation of the students, 86.49 % of the group leaders acknowledge the students' professional knowledge demonstrated in practice; 77.49 % of the group leaders think that what students have learned in school can meet the job requirements; 83.69 % of the group leaders confirm that the students master basic skills during the internship period.

(2) Concerning the ability quality evaluation of the students, more than 70 % of the group leaders consider that the students have the ability to find problems, analyze problems and solve problems; 71.17 % of the group leaders recognize creativity of students.

(3) Concerning the moral quality evaluation of the students, 80 % of group leaders recognize the students' performance in ethics and responsibility; 68.38 % of the group leaders accept the students behavior of law-abiding during the internship period.

Through the above analysis of the survey questionnaire we can see, the pilot internship has achieved good results, and provides a new way of thinking and a new paradigm for a new model of collaboration education between universities and enterprises.

150.3 The Role of Advisers in Internships

150.3.1 Build Bridges Between Colleges and Enterprises

Modern education and business are inextricably linked; between the two are interrelated and mutually reinforcing relationships. However, higher education and enterprises belonging to different industries, collaboration between colleges and enterprises is not always easy to form. So we can learn from foreign experience to establish a special organization to build bridges between colleges and enterprises. In many foreign countries, various industry associations, professional intermediary organizations, foundations, research institutions and other non-governmental organizations have played a positive role to promote the development of vocational education. Especially in making industry standards, optimizing professional training standards, coordinating with the government on behalf of business and industry organizations, helping professional and technical personnel to fight for the legitimate rights and interests in enterprises, they can play an important and positive role.

150.3.2 Contribute to the Training of Highly Skilled Personnel

Internship implements instructor system, and is mainly reflected in the guidance education, inspiration and management of teachers to students. Instructors can implement individualized training of students which is more specific, so greatly mobilizing the initiative of students, tapping the potential of students, expanding the professional education and training the students' spirit of innovation, creativity and practical ability. This is helpful to equip students a professional technical expertise and innovation (Sun 2010).

150.3.3 Contribute to the Professional Growth of Advisers

In the internship, students are asked to choose instructors independently, which requires teachers to focus on self-education and learning, and constantly improve their level of scientific research and practical skills. It also requires the cooperative enterprise to send instructors with excellent skills and high moral character. Our internship experience shows that instructors, consciously or unconsciously, improve their own quality and business level, thus contributing to the self-optimization construction of faculty.

150.3.4 Help Strengthen the Management of Vocational Students

Previous colleges implement counselor or teacher control system, in which there is a phenomenon that student management and teaching management are independent of each other and the two are non-interference. For example, managers do not know the students' professional learning, while specialized teachers do not know the students' employment status. Implementation of mentoring can minimize this situation. Teachers are not only disseminators of knowledge, but also guides for students' life. This allows previous students administration to transform from "management" to "guide", two approaches work together to make the daily management of students and academic development linked together, playing a role to complement and strengthen the student management.

150.4 The Construction of Advisers

150.4.1 Enhance the Training of the Double Competency Teaching Staff

The training of students in the cooperation between colleges and enterprises focuses on ability cultivation, objectively requiring advisers to have double qualifications. The double qualifications include solid theoretical knowledge and strong practical skills. If teachers become unadoptable to the requirements, college's development will be limited and existence will be affected. The cooperation between colleges and enterprises and mutual support of relative advantages can advance educational reform, improve the quality of education and instruction and cultivate double competency teaching staff (Chen 2010).

It is strong support for the success of internship practice teaching to construct "double strength" practical guidance teachers with a strong sense of responsibility and ability to work. During this internship, college cadres take lead in carrying out imprisoned system, and professional advisers and full time counselors make a double strength team. Intern advisers are divided into the ones on duty and the ones off duty. Advisers on duty and counselors go to workshop to visit intern students in turn every day, listen to their suggestions and note all the things on internship on-duty diary. If emergency happens, teachers can arrive in the site in time and solve problems quickly.

150.4.2 Diversification of Faculty

Internship in the cooperation between colleges and enterprises are very effective to cultivate double competency teaching staff. Development of internship can make teachers deepen produce practice, achieve the organic integration of theory and practice, familiar with the needs of local and industry, Enhance work and social experience, raise academic standards and the ability to analyze and solve site problems. In addition, experienced professional technicians in corporations are the best supplement people to double competency teaching staff. The key to cultivate practical capable personnel in the cooperation between colleges and enterprises is to have open and diversified teaching staff. Introducing cooperation corporation trainers, engineers and post masters is a way to realize diversification. There are two effects to introduce outside school instructors, which include corporation trainers. One is to solve the problem of cultivating practical capable personnel. The other is to mutually benefit the two-side teaching staff in the collaboration education between universities and enterprises and to make up the deficiency in the original teaching and training (Li 2010; Zhan and Dai 2010).

150.4.3 Build a Stereo Metric Teaching Staff Team

In order to let students be more capable of mastering skills and serve society more quickly, building stereo metric teaching staff teams is necessary, such as life coach teams, skills coach teams and knowledge coach teams. Life coaches are made by counselors, who focus on the administration of class daily affairs and students' life. Skills coaches consist of corporation experts and technicists, who mainly instruct and teach students professional knowledge, professional skills and the ability to operate practically. Knowledge coaches contain teachers of professional teaching and research section with the main task of instructing students to master the essential basic knowledge to instruct practice, improving students' comprehensive quality, enhancing students' cultural deposits and developing students' different strong points. Depending on counselors' professional condition, responsible teachers hold posts of life coaches. Skills coaches are elected by corporation, selected bilaterally by students and corporation coaches. Coaches make cultivation plans, meet students regularly and at the same time instruct the train in outside school internship sites. Knowledge coaches contain all specialized course teachers. According to his skill services, laboratory construction and training projects, each teacher select a certain number of students to join him (Yan et al. 2009).

150.5 Conclusions

All the facts have proven that college-enterprise joint internship teaching is successful. It is an effective way to innovate the mode of talent training in the collaboration education between universities and enterprises. Results of questionnaire survey suggest that internship enhances students' ability to operate practically and integrate theory with practice, cultivates their professional accomplishments, and improves their comprehensive qualities and vocational skills. Furthermore, through the understanding of corporation production process and corporate culture, the internship clarifies students' employment concepts and ideas, establishes good basis of further study and employment, increases their employment competition after graduation. The success of internship lies in the construction of stereo metric double competency teaching staff. Instructors play an important role during the internship period and make contribution to improve internship quality, guarantee internship progress and enhance the cooperation between colleges and enterprises.

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Chapter 151
Study on Using Public–Private Partnerships to Develop Management and Recycling of Demolition Waste

Gang Chao, Deng-yue Li and Mei-hua Qiu

Abstract This paper analyzes a policy management tool applied in construction and demolition (C&D) waste recycling. With the rapid development of urbanization and the construction industry, the C&D waste recycling becomes a chronic problem in the urban management. After introducing the basic features and advantages of the PPP (Public–private partnerships), the paper investigate the disposal and reclamation of C&D waste in Guangzhou City and analyzes the feasibility of PPP applied in C&D waste recycling from the aspect of policy, economy and technology. Moreover, the study establishes the way of operation and types of PPP. Hopefully, the paper can do well for the reclamation of C&D waste.

Keywords C&D waste · PPP model · The reclamation of C&D waste

151.1 Introduction

In recent years, with the rapid development of the construction industry, it will inevitably lead to the rapid growth of construction and demolition (C&D) waste. The data of the Ministry of Housing and Urban–Rural Development shows that Construction area in 2007, 2008 and 2009 is 4.116 billion square meters, 47.32 million square meters and 5.873 billion square meters (Liu 2009).

G. Chao (✉) · D. Li · M. Qiu
School of Business Administration, South China University of Technology, Guangzhou, China
e-mail: gzhao@scut.edu.cn

D. Li
e-mail: lidengyue@gmail.com

M. Qiu
e-mail: 304765890@qq.com

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The empirical data of abroad shows that about 20–40 kg of C&D waste will be generated every square meter of housing area in the process of building housing (Lauritzen 1994). Given the low level of construction management, more C&D waste will be generated in China than in developed country. About 500–600 kg of C&D waste will be generated every square meter of housing area in the process of construction (Kai-an 2005). Assuming that the annual housing areas are all newly built, the total amount of C&D waste generated throughout the country would be close to 810 million tons in the past 3 years. Assuming the annual area of demolished buildings accounts for 10 % of the total area of construction, the total amount of C&D waste in the country would turn to 1,400 million tons in the past 3 years.

The fast growth of C&D waste has caused much management pressure to the government departments in cities. To government departments, the state and local government have already attached great importance to the C&D waste issue because of its urgency and seriousness. But if just rely on the government; it cannot meet the need of city development, neither in the money supply nor operation efficiency. It is an inevitable requirement to build C&D waste recycling marketing operation in a commercialized manner. The private-owned enterprises in construction disposal industry are providing social services and achieving social benefit as well as winning market and economic benefits.

151.2 Regulation Measures of C&D Waste and Existing Problems in Guangzhou

151.2.1 The Status and Goals of Guangzhou C&D Waste Recycling

With the rapid and sustained development of National economy, the ever-increasing amount of solid waste generation has created disposal problems for many cities. According to the Guangzhou sanitation department estimate, Guangzhou produces 20 million tons C&D waste every year, and there are also about 40 million tons C&D waste that have been stored up for 20 years, so the total number of the C&D waste in Guangzhou would be 60 million tons.

<The Cantonese long-term plan for Comprehensive utilization of resources> explicitly pointed out that we should vigorously carry out the comprehensive utilization of C&D waste sorting technology, equipment development and application, expanding method of classification, reclamation, safe treatment, so as to improve the rate of waste recycling. On the regional distribution, The plan pointed out that the amount of Utilization of C&D waste will be increased from 0 tons in 2009 to 500 million tons in 2015, 10 million tons in 2020, in the direction and emphasis of the comprehensive utilization of building materials resources (The Economic Information Commission of Guangdong Province, Lauritzen 1994).

151.2.2 The Major Problems Existing in the C&D Waste Recycling in Guangzhou

Over the years, the way that Guangzhou city treats the C&D waste basically follows the principle that "the one who produces C&D waste is liable for disposal". By using the system of disposal permission and charging, In recent years, the minimization and recycling of C&D waste, issues have received increasing attention, but because of too many historical debts, unsound capital investment system and the unsupported management and supervision system, there are still a large number of problems in the C&D waste disposal, and recycling problem is more outstanding. Mainly in:

Firstly, with the rapid growth of construction waste, Great pressure of waste disposal and outdated technologies compared the refuse processing sites and methods have not got relevant development. Currently there are only two standard refuse processing plants in Guangzhou city, one is in Huadu district with 6 million cubic meters designed capacity; the other is in Luogang district with 0.3 million cubic meters designed capacity (Chen 2011).

Secondly, single financing channel and short of fund. The development of modern economy and urbanization demands urban infrastructure to go ahead of the rest, the growth rate for investment is higher than that of national income growth and cannot meet the demand for urban infrastructure construction if totally relied on government current income. Recycling utilization of construction waste is a capital-intensive industry. According to ZhuYing's study on C&D waste concrete recycling project, it will takes billions of RMB to build up a recycled concrete plant with production capacity of 400,000 tons (Wang 2003).

To accomplish the above goal, it needs to construct a variety of waste disposal facilities for about 5 million annual disposal capacities from 2010 to 2015, which amounts for 1.3 billion RMB.

C&D waste recycling has always been taken as public welfare undertaking, almost rely on government investment. However, based on statistics, although the problem of construction waste becomes more prominent, government's responding investment tends to decrease. (Table 151.1). The gap between investments and demand continues to expand, result in the restriction the effective implementation of government regulation functions, which is also a very important reason for the deferred advancement in the recycling utilization project of waste.

Thirdly, charging method is difficult to encourage recycling.

Urban Solid Waste Management was adopted in 1995, which requested the garbage producing departments pay for the disposal fee, aiming to reduce garbage generation from the stem. This cannot stop garbage producing from the stem, as for most of trash producing enterprise; it does not have much impact on them to pay the disposal fee. In comparison with reclamation of construction waste, it costs less in short term and the law does not cover the question of waste recycling utilization. The level of charging standard is low in our country, on the one hand, it is difficult to urge enterprise to reduce emission of waste actively by charging

Table 151.1 Amount of the government investment in C&D waste disposal in Guangzhou

Years	Fixed assets investment in construction of public facilities (million)	C&D waste investment (million)	The proportion (million)
2005	23,25,685	40,932	1.76
2006	22,25,403	34,889	1.57
2007	21,17,075	14,070	0.66
2008	19,56,711	20,114	1.03
2009	41,70,016	19,690	0.47

them; on the other hand, fund subsidized to enterprise for waste recycling is limited.

Fourthly, both the current rate of multipurpose utilization and the recycling rate in Guangzhou are low.

Due to fewer companies are specialized in trash reclamation treatment in Guangzhou, the leveler of scientification and the standardization is quite low, making it difficult to form scale economy and handle larger volumes of C&D waste.

Most of recycling methods of C&D waste are single with simple treatment and low rate of resource use. The proportion of disposal of C&D waste is only about 40 %. It is mostly used in three connections and one leveling projects and newly built buildings. To sum up, the recycling of C&D waste is still at the initial stage, and a large number of C&D waste is not included in the unified management system. As the consumptive field capacity of C&D waste is also getting smaller and smaller. Many depressions have been filled or planned land has been developed, this kind of means is hard to be carried on.

151.3 The Characteristics of PPP and the Way to Solver the Problem of Recycling C&D Waste

151.3.1 The Meaning and Characteristics of PPP Model

Public–private partnership denotes a sophisticated interface between public authorities and private sector undertakings which aims at delivering infrastructure projects, as well as public services. According to the EU institutions, the term public–private partnership refers to "forms of cooperation between public authorities and the world of business which aims to ensure the funding, construction, renovation, management or maintenance of an infrastructure or the provision of a service" (United Nations 2008).

The United Nations followed and embraced the concept, denying public private partnerships as 'innovative methods used by the public sector to contract with the private sector, who brings their capital and their ability to deliver projects on time and to budget, while the public sector retains the responsibility to provide these services to the public in a way that benefits the public and delivers economic development and an improvement in the quality of life' (Saves 1982).

As a policy management tool, PPP has been widely used in the areas that processing the characteristics of public goods, and of private goods. There are many public services programs supply in the form of PPP, which is funded by the government and produced by private sector. For example, in the USA, there are 339 PPP programs of garbage collection, 143 PPP programs of garbage disposal and 67 PPP programs of water treatment (Ge 2002).

Chinese Urban infrastructure projects are beginning to use the PPP mode. The first program which successfully used PPP was the main venue of the 29th Olympic Games, which is also called "Bird's Nest" project. In 3.5 billion Yuan of total investment of the project, the government funded 58 %, by investing only 2.03 billion Yuan on the construction of the project, so greatly reduced the financial burden, on the other hand. Commonwealth of CITIC Group funded 42 %, and got a 30-year franchise through investment of 1.47 billion Yuan (Li and Liu 2007).

With the rapid development of Chinese economy in recent years, more and more private capital began to focus on urban infrastructure construction investment. The PPP model is undoubtedly the ideal model of choice of private capital participation in urban infrastructure construction and private capital to participate in urban infrastructure construction.

151.3.2 The Theoretical Feasibility of Using the PPP Model to Solve the Problem of Recycling C&D Waste

As for welfare, C&D waste management is considered as public goods with strong external nature to be served by government, this cognition is based on shallow analysis on the attribute of public goods. Kessides (1993) summarized the characteristics of solid waste treatment industry (See Table 151.2), after analyzing factors as follows: the competitive level, exclusive degree, sunk degree of production, economies scale, cooperation requirements and externality (Kessides 1993).

It is observed that waste disposal industry is not exclusive on consumption, and there is certain competitiveness with supply, waste transportation and resource recycling, which are not consistent with the nature of public goods and the properties of pure public goods (Zou 2008).

151.3.3 Policy Basis for the Application of PPP Model in the Resolution of C&D Waste Recycling Problem

In June, 2002, The State Planning Commission, Ministry of Finance, Ministry of Construction, State Environmental Protection Administration jointly issued a

Table 151.2 Characteristics of the solid waste disposal

Manner	Essential character of service		On the producer side		Externality
	Competitive extent	Exclusive extent	Economic scale	Extent of cooperation requirement	
Gathering	Median	Median	Low	Median	Public health, land pollution, water pollution
Transportion	High	High	High	High	
Landfill treatment	Low	Median	High	High	
Incineration	Median	High	High	High	
Resource recovery	High	High	Low	Low	

notice <on the implementation of municipal solid waste disposal fees to promote the waste disposal industry>, fully implemented C&D waste disposal fees. It is also puts forward that waste disposal company should introduce competition mechanisms by carrying out the separating government administration from enterprise management (The State Planning Commission 2002).

Through public bidding, qualified enterprises are chosen to response for garbage disposal and demand city construction administrative supervision department to establish market admission system, In February 2005, the state council has announced <certain opinions on encouraging, supporting and instructing the individual private and other non-public sectors>. For the first time the government explicitly allowed private capital to enter the monopoly areas of electricity, telecommunications, railway, civil aviation, etc. As well as supporting private capital to actively participate in the investment, construction and operation of municipal utilities and infrastructure, encouraging non-public enterprises to participate in property relations and business model's reform of municipal utility enterprises and institutions.

The issue of "new 36" breaks the monopoly of the industry, extend to inside open, it also encourages and guides private investment to participate in public welfare undertakings and infrastructure projects. Besides, it solves the dynamic problem of civilian capital admittance. Promulgation of the "new 36" has great strategic and economic significance (The state, Several opinions of The State Council on encouraging and guiding the healthy development of private investment 2010).

151.3.4 Analysis of the Technical Feasibility of C&D Waste Recycling

C&D waste recycling technology includes recycled aggregate technology; regeneration block technology recycled concrete technology. Among them, building block technology is the most mature which has reached the commercial level and used in the big light commercial center of Handan City, the National Business Center and other projects (Li and Liu 2007); Although regeneration

Table 151.3 Development status of solid renewable technology

Skill type	Technological maturity and development stage		
	Research and development stage	Pilot demonstration stage	Commercialize stage
Solid waste utilization	Δ	Δ	
Recycled aggregate	Δ	Δ	
Regeneration block	Δ	Δ	Δ
Recycled concrete	Δ	Δ	
Muck	Δ		
Coal gangue	Δ	Δ	Δ
Scrap metal recycling	Δ	Δ	Δ

aggregate and recycled concrete technology has not reached to commercial degree, yet it has already entered the promotion stage for typical project demonstration, belonging to relatively mature technology. Technological maturity of main garbage regenerated technologies is showed in Table 151.3.

151.3.5 Analysis of Economic Feasibility of C&D Waste Recycling

There are several raw materials needed in daily production of C&D waste recycling: C&D waste, Cement, coal ash and so on. The condition for raw material supplying market is like below (Youlan 2006):

1. Construction waste can be coordinated by the Guangzhou municipal government, all (a certain percentage) of C&D waste after classification will transported to the construction of waste disposal station by the joint venture company’s fleet.
2. Cement. Mainly used in the production of light weight block, well-supplied by the markets, so can be bought on the market. We should develop appropriate standards and determine the supply unit and is in abundant supply. It should be purchased from the market by setting up certain standards to ensure stable supplying firms.

In addition, as the country’s great effort in the prohibition of the use of clay brick, Modern architectural wall materials providing great opportunity of development and the broad market space for new building materials such as baking-free brick. According to the Guangzhou planning, the proportion of recycled products procurement by Guangzhou municipal government should be increased year by year. The rate of recycled products procurement by government agencies should rise up to 30 % by the year 2015.

Apparently, recycling products of C&D waste is competitive in policy and product performance, with capacious market prospect.

151.4 PPP Operation Mode of C&D Waste Recycling Project

151.4.1 Organization Structure of the PPP Model

Combined with the nature of the C&D waste disposal industry, the organization settings of the PPP mode is shown in Fig. 151.1.

151.4.2 Operating Program of the C&D Waste Disposal Station

There are three major income sources in the operation stage of waste disposal station, they are as follow:

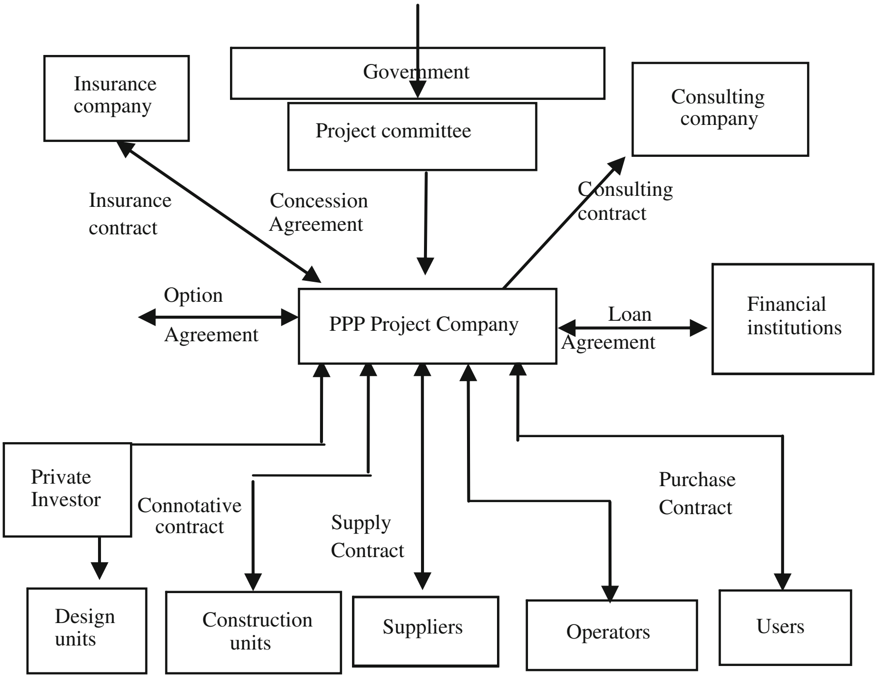

Fig. 151.1 The organization settings of the PPP mode

Firstly, it will charge the construction companies for waste management. <Guangzhou solid waste pollution prevention plan (2005–2015)> clearly pointed out that, it is a general principle for either polluters or users to pay the management fee in pollution as well as in solid waste pollution prevention and treatment. It is the foundation for marketization for either polluters or users to pay the management fee. Government, waste management company, all related experts need to participate in the consultation of the waste management costs, the joint venture company can reported program first, providing reasons to grasp the initiative in pricing, at last the price is reviewed by the pricing team formed by governments and experts.

Secondly, charge government the service fee or subsidy by contract. The costs and administrative transfer have substantial distinction. It is confirmed by measured garbage discharge quantity, the cost of collection, transportation and treatment of per ton garbage, the environmental protection.

151.5 Conclusion

In summary, industrial development of C&D waste recycling is the inevitable future of urban development, application of PPP mode to solve the Guangzhou construction waste resources. It is a practical program of solving the problems of inadequate investment, backward technology and low recycling rate. The government should further promote the construction waste recycling industry and public–private partnership process so as to enhance the level of construction waste resources.

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Chapter 152
Research and Exploration of International Industrial Engineering-Oriented Talents Cultivation Mode

Guang Cheng, Xiu-fang Sun and Ai-ping Yang

Abstract This article analyses the basic internationalization engineering personnel training needs, summarizes the current training situation, put forward notions of cultivating engineering professionals in the present circumstances to adapt to the internationalized education, and discuss the ways to better train industrial engineering students who can meet the internationalization requirements.

Keywords Internationalization · Cultivation method · Engineering talents

152.1 Introduction

In recent years, Chinese engineering technology has quickly moved on to the track of the international line with international standards, and is in the urgent need of the talents of international quality. But in the area of personnel training mode, there exists a big gap between our education system/concepts and those from overseas countries. Traditional ways of professional training for personnel training are still in the dominant use, which leads to the acute shortage of talents with international quality in China (Li 2002). There is an urgent need of cultivating talents' international view and innovation in China, in order to adapt to the ever-increasing international demand for quality talents. However, China's internationalized talents education has just begun and there are many problems. In view of these questions, Beijing Union University proposes the internationalization school ideas, and tries to explore how to better nurture capable personnel, who will meet the international requirement (Fu and Huang 2010).

G. Cheng (✉) · X. Sun · A. Yang
Department of Industrial Engineering, Beijing Union University,
Beijing, China
e-mail: chengguang@buu.edu.cn

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Cultivating the international engineering professionals refers to developing engineering students' general engineering background knowledge, international consciousness, ideas, vision and strategy.

The industrial engineering major has a history of near 100 years in the Western developed countries and plays a indispensible role in their economical launching, but it has just started in China since the enterprise separated from the planned economy and entered the market economy period. It was in the mid 90′s that formal industrial engineering professional education started in China, therefore it is not mature enough to function powerfully in personnel training.

152.2 Engineering Professionals Cultivation and Present Situation

China, as a developed country, implemented the Open Policy from 1980s and the economic development has merged into the world economy gradually. But the traditional teaching method has the obvious disparity with the internationalization demand, mainly in the following aspects:

1. Weaknesses in knowledge structure and overall quality: talents tend to be mediocre without obvious individual features, and not competitive enough since their social adaptive ability is relevantly weak;
2. lack of strong professional quality: Talents can not get down earth to do their work;
3. lack of practical ability: They can only do some basic technical work, with no capacity to undertake and manage large projects and major projects;
4. lack of innovation: they are lack of confidence, ability to work independently and to create; they don't have a strong willpower or firm goal and are easily frustrated; they are not able to carry out creative activities;
5. lifelong learning skills: the lack of continuous lifelong learning and knowledge management capabilities and habits, lack of self-development and realization of power;

Most of senior management in the domestic foreign-funded enterprises has received Western education at present. The proportion of our domestically educated talents working as senior management in foreign companies is comparatively below. The main reason is that talents we cultivate do not meet the standard of engineering talents in foreign companies. Local shortage of highly qualified personnel will bring difficulties to those multinational corporations doing business in China and Chinese enterprises expanding overseas. Companies are facing the trouble of finding suitable staff in key services and management positions. Lack of innovation, international thinking, and internationalization of engineering skills, together with poor English standard is the main reason that hinders Chinese graduates working for foreign companies. The traditional teaching mode is more theoretical, and relies on books and teaching materials and instructors to teach. All of these lead to lack of suitable international engineering and technical personnel, which directly affect China's becoming an economic power as soon as possible (Yang 2001).

152.3 Industrial Engineering Professionals Training and Direction

There is a big gap between engineering talent cultivation in China and the international requirement, but finding the target and actively pushing forward totally has the potential to quickly bridge the gap.

Industrial Engineering personnel training more in line with international requirements to an urgent need for the following areas to strengthen the work:

1. establishing training goals of internationalization

To establish an international training objective, in terms of ideology to cultivate the students' international awareness, mainly to promote the mutual understanding of different peoples, cultures and strengthen international understanding, so that students can gain a profound understanding of multiculturalism, can fully communicate ideas in the international cultural exchange, and can make judge start from a broad perspective of the international community and all mankind.

The introduction of target schools, teaching methods and standards established culture consistent with the direction of foreign target colleges and universities, training methods to the curriculum until the means of teaching positive introduction to learning, to avoid blind groping, do not work, and in high standard, which is Industrial Engineering rapidly into an international first-class shortcut. Industrial Engineering of Tsinghua University in this respect is in place, successful learning at Purdue University industrial engineering culture and teaching methods, and the professional quickly build a world-class professional.

2. the introduction of resources to promote the internationalization of faculty

Internationalization of students depends on the availability of international teaching staff, inviting foreign experts and scholars to serve part-time and channels of communication, to facilitate the process of internationalization of the school talent. Students ' exposure to the different cultural backgrounds of teachers of different views and methods, form a multicultural, international atmosphere of coexistence of multiple views, multiple ways of thinking, to foster students 'understanding of different cultures and the ability to analyze the problem from a variety of angles.

Strengthening the international construction of the internal faculty can actively establish measures to allow young teachers abroad for further studies to improve with a doctoral degree; Strengthening links with the internationalization of enterprises may selectively engage leading entrepreneurs to school part-time teaching or tempering to large and medium-sized enterprises; Building inter-school relationships with similar institutions abroad, faculty of industrial engineering specialty through visits, study and education, raise the level of academic and scientific research abilities, to adapt to the changing international situation of economic competition, engineering talent can be developed in line with international requirements.

3. Improving teaching content and curriculum system of industrial engineering, the professional course structure should be optimized in accordance with the international industrial engineering professional engineer certification standards and international professional certification standards. Graduates with international knowledge system, stronger adaptability and potential for further development are easier to be accepted by international companies. Industrial Engineering professionals in the United States have a mature certification standards and assessment methods, and professional engineers for the domestic education reforms to find a good basis.

The internationalization of the industrial engineering curriculum materials, Talent standard international requires courses and textbooks as core in the field of education reform to be on the internationalization path. Internationalization of education requirements to establish the concept of globalization of course, to learn from foreign advanced curriculum ideas, introduction, learn from foreign advanced materials, to build practical ability to cultivate the spirit of innovation and industrial engineering to solve practical problems as the core curriculum system, thus the need to vigorously promote the extent and level of internationalization of curriculum and materials to foster the international competitiveness of industrial engineering professionals.

Adjusting the curriculum to meet the needs of society, to really make the cultivation of China's industrial engineering students accepted by the internationalization of domestic enterprises, Investigations and studies should be conducted to directly the enterprise, according to the enterprise to the industrial engineering professional's specific request design teaching curriculum and the course content, strengthens in practically the teaching the theory divorced from practice weak link. Further build the curriculum system with international standards, to update teaching content, and focus on the most cutting-edge scientific and technological knowledge into teaching (Wu 2006).

4. Promoting exchange and cooperation with the business community

The training is designed for the business end, with the cooperation and exchange business essential, teachers and students must pay close attention of the practical issues. Therefore the industrial engineering specialized must establish the education teaching and practice base in the enterprise which the professionals raise; Experienced enterprise personnel can be invited to do the teaching.

5. the major categories of training, innovation education, based on model innovation

Industrial Engineering is a professional cultured composite applications personnel, and requires the teaching to include a more comprehensive engineering background knowledge of mechanics, control of both the management knowledge therefore need to coordinate Required classes, limited to the relationship between elective and elective courses, in order to mobilize the students' enthusiasm and initiative. In order to better address these issues, industrial engineering major in our University entered the machinery class enrollment, practice. This will help to improve the ability of students' general engineering technology, and better meet the needs of social development.

In order to change the phenomenon of impairing book knowledge and neglect of the ability and skills training, the teaching should reverse the theory divorced from the actual situation, the teaching content close to the practice of social production. Industrial engineering professional teaching training innovation ability is the main line, pay attention to the comprehensive quality of students.

This will be elaborated from the following areas:

1. Enhancing practice teaching, reflecting the strong capability, and high quality, the thinking through the social investigation, production internship guide students into future entrepreneurs, the case teaching role penetration occurred, taught in the professional development of students' responses, and of the capacity;
2. Establishing a relatively stable school, off-campus internships, practice base, to create a good engineering practice. There are plans to arrange for students to the norms of international business practice and improve their ability to work;
3. Establishing the second classroom, student competitions, training comprehensive ability of students;
4. Combining common effective ways of cultivating talent, relying on common training and international enterprise cooperation, enterprises engaged in professional orientation, curriculum development, and business specialist teaching of certain tasks simultaneously.

152.4 Discussion and Conclusion

In order to solve the problems listed above, training in line with the needs of international talent, Beijing Union University, Mechanical and Electrical Engineering Industrial Engineering (Modern Manufacturing Engineering Management) professional years a wide range of practice and exploration. Industrial Engineering in the advanced Western countries has a long history of development, in a sense, is the development of the discipline that ensures the United States and Japan become industrialized powers and economic power. But the profession in China is still a new profession, only 10 years old, is gradually developed with the enterprise market competition disciplines. Industrial Engineering of Beijing Union University is committed to the efficiency of the manufacturing and service systems to improve quality and safety assurance and cost reduction, lean improvement methods and techniques applied to manufacturing is our specialty, while the concept of lean design applied to the design manufacturing service and product innovation have achieved very good social benefits. The main practices are as follows:

1. Industrial Engineering certified in accordance with the international standard design the syllabus and training program, Taiwan, China University of Industrial Engineering with a higher level, from curriculum to teaching operation to refer to the experience of these colleges and universities. This same time, the assessment criteria in accordance with the American Institute of Industrial Engineers, modify and develop teaching programs.
2. To actively promote industrial engineering students engineer professional qualification certification. Beijing Union University, College of Mechanical and Electrical Engineering as the first batch of trainee industrial engineer examiners institutions and members of the Group school to carry out the first certification of trainee industrial engineer. The first batch of 30 industrial engineering third-grade students took the exam and the pass rate was 75 %. As the Beijing Institute of Industrial Engineers work unit, this played a lead trainee industrial engineer certified in the Capital Region.
3. Active exchange with the high-level international experts and scholars. Participate in and organize the field of Industrial Engineering International Conference, access to more mutual understanding and improve the opportunity. The IEEE sixteenth Industrial Engineering International Conference, organized in 2009 as the Undertaker, and there was to expand the impact of school and professional, and exercise to improve the team, and make friends. This at the same time actively seeks opportunities to introduce foreign teachers to teach and lecture for the students, laid the foundation for the Institute of internationalization school.
4. Actively apply for transverse and longitudinal research projects, training research team, to serve the community. Apply for the provincial and ministerial level scientific research topics, and enterprise scientific research topics. Lean improvement in the manufacturing and service systems, high-tech products, man–machine design is gradually recognized by the enterprise.
5. Actively organize industrial engineering students participate in undergraduate science and technology contest through the joint efforts of teachers and students, in the national logistics case competition and the capital of industrial engineering design competition for good results. To explore new ways to foster the internationalization of applied engineering talent.

Culture in line with international business needs of the industrial engineering professionals is a difficult process of innovation, and only through the tireless efforts and innovative thinking, can we truly cultivate the industrial engineering professionals with international thinking to meet the business needs.

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Chapter 153
An Empirical Study on the Relationships Between Entrepreneur and SMEs' Vitality

Feng-hai Zhang, Xiao-wei Ma, Wei-hua Yang and Yue-kui Xu

Abstract Entrepreneur is the driving force of survival and development of the small and medium-sized enterprises (SMEs), and is one of the most important factors which affect the vitality of SMEs. In this paper, we discussed entrepreneurs' own accomplishment of knowledge and practical experience, social networks (relationships between entrepreneurs and external stakeholders), cohesion of entrepreneurs (relationships between entrepreneurs and internal employees) and so on. This empirical study on the relationships between these 3 dimensions, 4 elements and SMEs' vitality was conducted based on 267 Chinese SMEs. The results show that practical experience, accomplishment of knowledge, cohesion and social networks play a positive role in promoting the continuous growth of the SMEs, and have a positive effect on SMEs' vitality.

Keywords Entrepreneur · SMEs · Enterprises' vitality

153.1 Introduction

SMEs play an increasingly important role in expanding employment, promoting economic growth, and promoting social harmony and stability. However, the general life of China's SMEs is not long, and the standard of their sustainable

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F. Zhang (✉) · X. Ma · W. Yang · Y. Xu
School of Management, Dalian Polytechnic University, Dalian, China
e-mail: fhzhang66@163.com

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growth is also poor. According to a special research report titled *Investigation and Recommendations of the SME Transformation and Innovation in Post-crisis Era*, issued by the Central Committee of China Democratic National Construction Association at the end of 2010, demonstrated that, at present, the average life expectancy of China's SMEs was only 3.7 years, whereas, Europe's and Japan's were 12.5 years, America's was 8.2 years, and 1/4 of 500 outstanding SMEs in Germany survived more than 100 years. Therefore, research on the problem of effect factors of SMEs' vitality in China has important practical significance.

153.2 Hypotheses

By reading the existing literature we found that, numerous studies had verified that there was a positive correlation between entrepreneur quality, entrepreneur competencies and enterprise performance (Teece et al. 1997). Hanks and Chandler's empirical studies showed a positive correlation between opportunity perception of entrepreneurs and enterprise performance, the management ability of entrepreneurs would bring about economic efficiency for the enterprise directly (Chandler and Hanks 1998). Entrepreneur competencies and competitiveness of enterprises has a significant positive correlation (Man 2001). The founder with rich entrepreneurial characteristics is the most important factor to promote high-growth enterprises' growth (Fischer and Reuber 2003). Entrepreneurs bring about performance through productive efforts, which meanwhile restrict the performance of entrepreneurial talents (Liao and Zhang 2006). Innovation ability, and entrepreneurs' capacity of organizing, decision-making, communication, and learning had a significant positive impact on SMEs' performance (Jing 2008; Yang and Chen 2001). Relational capabilities of entrepreneur has a significant positive correlation with enterprise innovation performance and business growth performance (Zhang and Lv 2010), and has a positive impact on enterprise performance (He and Li 2005; Li and Yang 2008). Entrepreneur's qualities has a significant positive effect on the growth of innovative-styled SMEs (Zhang and Liang 2011; Wang 2007).

In summary, most of the former empirical researches on entrepreneurs were mainly focused on the relationship between entrepreneur's quality or competencies and enterprise's performance (Chandler and Hanks 1994; Man et al. 2002). Entrepreneur's qualities are entrepreneur's characteristics, accomplishment of knowledge, the synthesis of the style and ability of entrepreneurs manifested in the innovation activities. Therefore, in essence, the study on entrepreneur competencies can also be classified in the study on entrepreneur's qualities. Research on the qualities is very broad and difficult to focus on. However, the core for enterprise to survive and develop is the "human" and resources related to human closely. Entrepreneurs, the most important human resource of SMEs, are the soul and the commander-in-chief of enterprise's survival and development. And entrepreneurs themselves, relations between entrepreneurs and "human" outside the enterprise—external stakeholders, relations between them and "human" inside the enterprise—employees, have a direct effect on the enterprise's ability of survival and development. Therefore, on the basis of existing researches, we focus on considering the "human" factor in this paper, revolving around entrepreneurs as "social man". That is to study the effect of entrepreneurs themselves, relationship between entrepreneurs and external "human", relationship between entrepreneurs and internal "human" on SMEs' vitality.[1]

Based on existing researches, we propose the hypotheses: entrepreneurs themselves, relationship between entrepreneurs and external "human", relationship between entrepreneurs and internal "human" will play a positive role in promoting the sustainable growth of SMEs, and have a positive effect on Enterprises' vitality.

153.3 Research Design and Methods

153.3.1 Questionnaire Design and Data Collection

This research mainly adopted questionnaire method, using Likert five points equidistant scale measurement. In this study we made the domestic manufacturing SMEs as the research object, and issued the questionnaires by the way of college students' holiday social practice. Most of the interviewees were entrepreneurs or senior managers. We issued 500 copies of questionnaires and recovered 310 copies, and the recovery rate is 62 %, of which 267 copies were valid. The rest recovered 43 copies were regarded as invalid, because some items were not completed or there were a large number of items which selected the same choice, so the overall effective rate is 86.13 %. Finally we made a statistical analysis of effective data by using of the SPSS13.0 data processing software.

153.3.2 Measurement of Variables

153.3.2.1 Measurement of Independent Variables

According to the early research of domestic and foreign scholars, this study preliminary selected "Entrepreneurs' number of times in creating new ventures", "Entrepreneurs' experience of management", "Entrepreneurs' educational background", "Entrepreneurs' number of times of participating in training", "Rate of employees' support", "Degree of emphasis on employees' views", and "Network of social relations" as independent variables to carry on the questionnaire design, and then extracted common factors with the method of exploratory factor analysis

[1] In this paper, SMEs' vitality = F (Survival ability, Development ability).

in the data analysis phase. Finally, we used the method of regression analysis to study the relationship between the common factors (independent variables) and Enterprises' vitality (dependent variable).

153.3.2.2 Measurement of Dependent Variables

SMEs' vitality contains the ability of survival and development. In this paper, we used sales changes of the last three years and enterprises' age, these two aspects to reflect their ability of survival, and used enterprises' scale changes in the last three years to reflect their ability of development. Sales changes were measured by Likert-fifth measuring scale, that is to say, the greater the value, the more powerfully to reflect the ability of survival; enterprises' age was represented as the fixed number of years from the creation to the time of this survey, that is to say, the longer the year, the more powerfully to reflect the ability of survival; enterprises' scale changes were also measured by Likert-fifth measuring scale, that is to say, the bigger the number, the more powerfully to reflect the ability of development. Owing to 1.9 years average age of the sample enterprises (93 % within three years), Likert-fifth scale values range from 1 to 5, variables' order of magnitude, such as sales volume changes, the change of age and scale, was considerable. So we didn't consider each variable's weight temporarily, and just took the three's mean value to calculate the vitality. The formula of enterprises' vitality is $Y = (a+b+c)/3$. "Y" represents SMEs' vitality, "a" represents sales changes, "b" represents the enterprise's age, and "c" represents the changes in the scale.

153.4 Data Analysis and Results

153.4.1 Reliability Analysis

First we made a reliability analysis of the whole questionnaire items. The following table is the analysis results.

Table 152.1 shows that Cronbach α value of the reliability is 0.881. It illustrates that consistency degree of measurement is higher. P value of F Test, that done by repeated measure analysis of variance, is less than 0.01, which shows that the repeated measure of the scale is good, so the reliability reaches an acceptable level.

Table 152.1 Reliability analysis of the questionnaire

Item dimensions		Total questionnaire
Cronbach	α	0.881
Analysis of variance	F	109.123
Analysis of variance	P	0.000

153.4.2 Exploratory Factor Analysis

According to the quantifiable principles, we designed 9 options, of which 2 used descriptive statistics, and 7 were carried on by factor analysis. (Table 152.2).

KMO is 0.600, it shows that the data is suitable for factor analysis. The significance probability of χ^2 statistics value is 0.000, less than 1 %. It means that correlation coefficient matrix can not be seen as identity matrix, variables between each other is not independent, and they are correlative, so this data is suitable and needed for factor analysis (Xue 2010).

We used Varimax orthogonal rotation to extract factors, and 4 factors were extracted from 7 question items. Table 152.3 is the results of factor loadings after orthogonal rotation matrix.

According to the factor analysis, we extracted 4 factors; we named "Number of times in creating new ventures" and "Experience of management" Factor 1 "Practical experience". In a similar way, "Entrepreneurs' educational background" and "Number of times in training" were named Factor 2 "Accomplishment of knowledge"; "Rate of employee's support", "Degree of emphasis on employee's views" were named Factor 3 "Cohesion"; and "Network of social relations" was named Factor 4 "Social networks".

153.4.3 Regression Analysis and Hypothesis Testing

SMEs' vitality was taken as the dependent variable, and the 4 factors above were taken as independent variables, we established the following multiple linear regression equation:

Table 152.2 KMO and Bartlett's test

Kaiser-Meyer-Olkin measure of sampling adequacy		0.600
Bartlett's test of sphericity	Approx. Chi Square	1.192E3
	Sig.	0.000

Table 152.3 Factor extraction results of entrepreneur

Independent variable	Factor loading values			
	1	2	3	4
Number of entrepreneurs venture	0.946	0.104	0.183	0.011
Experience of management	0.944	0.114	0.203	0.040
Entrepreneurs' educational background	−0.104	0.947	0.150	0.008
Number of entrepreneurs training	0.248	0.916	0.081	−0.055
Rate of employee's support	0.096	0.124	0.946	0.146
Degree of emphasis on employee's views	0.369	0.132	0.868	0.098
Network of social relations	0.034	−0.039	0.172	0.984

Note Factor extraction method: Principal Component Analysis

$$TI = A_1X_1 + A_2X_2 + A_3X_3 + A_4X_4 + B$$

TI represents SMEs' vitality, A_1……A_4 are regression coefficients, X_1 represents Practical experience, X_2 represents Accomplishment of knowledge, X_3 represents Cohesion, X_4 represents Social networks, B is constant.

According to Table 152.4, we saw that 4 independent variables came into the regression equation, and the coefficients of these factors were significantly different from 0 at the level of 0.01. It means these 4 factors could be used as explanatory variables in the model to explain the strength of SMEs' vitality. So we got the regression equation of entrepreneur and SMEs vitality:

$$TI = 0.722X_1 + 0.293X_2 + 0.548\ X_3 + 0.140\ X_4 + 3.509$$

According to the above analysis, we saw that Practical experience, Accomplishment of knowledge, Cohesion and Social networks would have a positive effect on SMEs' vitality, and all of hypotheses got to be verified. So the theoretical model could be constructed (Fig. 152.1).

Table 152.4 Regression analysis results on enterprises' vitality and entrepreneur factors

Model	Non-standardized regression coefficients		t	Sig.
	B	Std. Error		
Constant	3.509	0.045	77.836	0.000
Factor 1	0.722	0.045	15.987	0.000
Factor 2	0.293	0.045	6.482	0.000
Factor 3	0.548	0.045	12.123	0.000
Factor 4	0.140	0.045	3.104	0.000

Note After adjustment: $R^2 = 0.634$, $F = 113.549$, $P < 0.01$

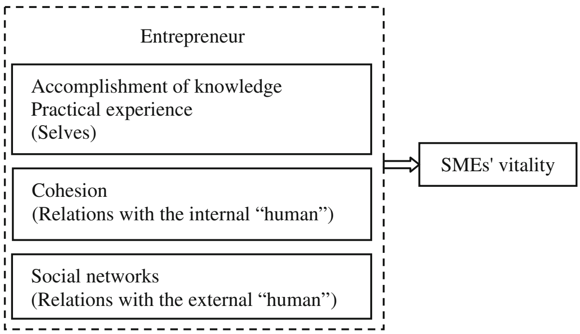

Fig. 152.1 Theoretical model

153.5 Results and Discussions

153.5.1 Practical Experience and SMEs' Vitality

It can be seen from the regression analysis that, the effect value of practical experience on vitality is 0.722; practical experience is the most significant factor of entrepreneur element effect on SMEs' vitality. Work experience (including entrepreneurial experience) is helpful for entrepreneurs to make effective management and decisions, and they can learn lessons from failures, avoid detours and grasp the correct direction of the development accurately. In this research, 91 % of entrepreneurs have 4 to 12 years of management experience; even 7.3 % have more than 13 years of experience, 72.7 % of entrepreneurs had 2 to 4 times of entrepreneurial experience. Obviously, practical experience of the entrepreneurs has an important effect on SMEs.

153.5.2 Accomplishment of Knowledge and SMEs' Vitality

The effect value of accomplishment of knowledge on vitality is 0.293, which is the third significant factor of entrepreneur element effect on SMEs' vitality. A good educational background and follow-up study or training can help entrepreneurs have a more complete knowledge structure, acquire the modern management of scientific knowledge concerned with the work of corporate leadership, and master the professional knowledge concerned with business activities. These will help entrepreneurs to fulfill their management responsibilities better and manage their enterprises more effectively. Meanwhile, it reminds our entrepreneurs that only by establishing the concepts of lifelong learning, updating their knowledge and ideas constantly can them keep the enterprises built to last.

153.5.3 Cohesion and SMEs' Vitality

The effect value of cohesion on vitality is 0.548, which is the second significant factor of entrepreneur element effect on SMEs' vitality. Cohesion will help entrepreneurs maintain good relations with employee, pool the wisdom and efforts of everyone, and form a good cultural atmosphere. At the same time, it will be conducive for entrepreneurs to know how to judge and use people truly, let each person do his best according to his ability, give full play to the initiative, enthusiasm and creativity of each employee, enabling enterprises to maintain strong vitality.

153.5.4 Social Networks and SMEs' Vitality

The effect value of social networks on vitality is 0.140, which is the fourth significant factor of entrepreneur element effect on SMEs vitality. If entrepreneurs establish good interpersonal relationships with external stakeholders, not only can they significantly reduce the uncertainty faced in the process of enterprise growth, but also obtain a lot of entrepreneurial resources, alleviating the general problem of resource constraints in the growth of SMEs effectively. In a word, social networks can enhance their ability of adapting to complex and external environment, to achieve sustainable growth.

153.6 Research Conclusions

The results show that practical experience, accomplishment of knowledge, cohesion and social networks have a positive role in promoting the continuous growth of the SMEs, and have a positive effect on SMEs' vitality. Practical experience made a greatest contribution to SMEs' vitality, followed by cohesion of the entrepreneurs. The significance of accomplishment of knowledge and social networks lived one by one behind the former two. So entrepreneurs, besides upgrading their accomplishment of knowledge through lifelong learning continuously and establishing a good network with external stakeholders, more importantly, they need the courage to practice and give full play the creativity of subordinates, so as to enhance the survival and development capacity of the enterprises.

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Chapter 154
Public–Private Partnership: The New Phenomenon

Sonali Chakravarti Banerjee and Arundhati Bhattacharyya

Abstract The ever increasing growth in urban population today has imposed tremendous pressure on State resources. In this situation, public–private partnership (PPP) can offer a solution to resource scarcity. It is defined as an arrangement between government and private sector bodies, for the purpose of providing public infrastructure and public services. Government and private sector bodies join hands to supply infrastructure and services to the members of the public. Such partnerships are believed to be characterized by the sharing of investment, risk, responsibility and reward between the partners. The underlying logic for establishing partnerships is that both the public and the private sectors have unique characteristics that provide them with advantages in specific aspects of service or project delivery.

Keywords Partnership · Public–private partnership · Political philosophy

The PPP strategy is evolving as a major plank for development efforts in many parts of the world today. In the 1980s, the term in vogue was privatisation. But the word gradually acquired a broader meaning, and by 1987, Savas defined privatisation as the act of reducing the role of government, or increasing the role of the private sector, in an activity or in the ownership of assets. Savas (1987) dealt with the contemporary American and European thrusts toward privatisation, but carefully admitted that, in a basic sense, public–private bonds were ancient and classical (Ibid., pp. 290–291).

Milton Friedman, Gordon Tullock, Anthony Downs, William Niskanen and Peter Drucker have been some of the more well-known scholars who popularised the concept of privatisation. But gradually, public–private partnerships became a

S. C. Banerjee (✉)
Department of Political Science, University of Calcutta, Kolkata, India
e-mail: bidyut53@yahoo.co.in

A. Bhattacharyya
Department of Political Science, Bhairab Ganguly College, Belgharia, India

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more fashionable term and by 2000, the wide-ranging spectrum of public–private bonds constituted the central theme of the relevant discourse (Savas et al. 2000). It has been suggested that the word “privatisation” is now being consciously avoided, as it has been thoroughly discredited. Nice-sounding phases like PPPs are being used for covertly ensuring riskless profits by the private sector. It has been specifically alleged that the World Bank has been promoting the PPP model so that investment becomes the responsibility of the government, while management becomes the prerogative of the private companies (Bhaduri and Kejriwal 2005). Scholars have indicated that privatisation and PPPs often actually throw open the debate about the rights of communities against the rising demand from industry (Das and Pangare 2006).

154.1 Evolution

Public–Private Partnerships (PPPs) are fast evolving as the new ‘panacea’ for the Indian state. In the 1950s, the solution lay in growth. In the 1970s, anti-poverty programmes were the magic potions. In the 1990s, the buzzword was liberalisation. In the current decade, the answer appears to lie in the PPPs. Like all other concepts, the term PPP also has its coordinates in its immediate context. Classically and philosophically, it could be plausibly argued that all businesses of civil societies and states are functions of public–private partnerships. Social contract theories hinted at this possibility and the king of Locke was certainly a partner in an agreement. When Green suggested that will (and not force) was the basis of the state, he was merely confirming that the public body was a partnership business of the members of the public! But the current term PPP seldom explores these hidden depths. PPPs are defined, strictly and narrowly, as the arrangements between government and private sector entities for the purpose of providing public infrastructure, facilities and services. PPPs emerged in this manner from the womb of *privatization.* The word *privatize* first appeared in a dictionary in 1983 and dominated the discourses for years. But by 2000, public–private partnerships were sounding more fashionable (Savas 2000).

It has been suggested that well-packaged phrases like PPPs better ensure riskless profits by the private sector. It has been hinted that the World Bank has been promoting the PPP model so that investment becomes the responsibility of the government, while management becomes the prerogative of the private companies. But even without being driven by the World Bank, public systems may woo private investors for meeting infrastructure gaps and/or for improving the reach/quality of public services, without escalating financial deficits. By itself, that is not a bad goal.

What could probably be a more value-neutral proposal is that the underlying principle of all PPPs is de-bureaucratization, and it is here that the PPPs are intrinsically linked to the primary concept of privatization. Privatization carried a sense of abdication by the state. Public–private partnering is more honourable for the state and certainly not undignified for the private side either. In this sense, it is definitely a nice-sounding phrase. But the problem is, the new phrase is yet to actually acquire new contours. The shadow of privatisation looms large on PPPs.

Scholars have indicated that sometimes private initiatives for entry into public spaces have been suspected to have assumed the character of para-statal elite clubs.[1] Several state governments passed laws to enable the private sector to participate in building infrastructure in late 1990s and early 2000s. Government of Gujarat passed the Gujarat Infrastructure Development Act in 1999. Government of Andhra Pradesh passed the Andhra Pradesh Infrastructure Development Enabling Act in 2001. In both the cases the Acts laid down the basis and conditions for private sector participation in infrastructure building. Emphasis was on roads, bridges, power and in some cases, services like water-supply.

In 2005, the Government of India introduced a Scheme for Support to Public Private Partnerships in Infrastructure. The scheme mentioned that the central purpose to evolve the PPP strategy is to attract private capital and the private sector's techno-managerial efficiencies towards the development of infrastructure. The scheme provides for viability gap funding.

In the last few years, many important projects in India have been implemented in the PPP mode. New airports have been constructed: for example, Hyderabad Rajiv Gandhi International Airport is a PPP project, constructed on BOT (Build-Operate-Transfer) basis (with 60 year's operation tenure) by a private company. The name of the private company is GMR—Hyderabad International Airport Limited. Many new road and flyovers have been constructed on a similar BOT basis. Delhi-Noida toll road, Mumbai-Pune toll express way and Chennai-Pondicherry toll road are some of the important examples.

Many civic services have also been subjected to PPPs. Chennai and Hyderabad as well as many other cities in India has experimented with PPPs in solid waste management sector. In Tamil Nadu PPP strategies have been used also for water supply and sewage treatment services.

PPPs have been used in many states in the housing sector and for redevelopment of slums and markets. The PPP experiments conducted in Mumbai in these sectors are particularly prominent. Brihanmumbai Mahanagarpalika or the Municipal Corporation of Greater Mumbai recently experimented with the redevelopment of the century old Crawford Market in the PPP mode.

PPPs have sometimes been attempted in the sector of governance reforms also. When S. M. Krishna was the Chief Minister of Karnataka, he allowed a private sector group to enter the domain of city administration for reforming the policies and practices of city governance. The name of this group was Bangalore Agenda Task Force. Many prominent citizens of Bangalore were members of this group. Nandan Nilekani, the then CEO of the famous IT Company Infosys Corporation, led the private citizens involved in BATF. These private citizens joined hands with

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[1] Planning Commission, Faster, Sustainable and More Inclusive Growth: An Approach to the 12th Five Year Plan, August 2011, pp. 143–151.

the municipal authorities for bringing funds to the city from private trusts as well as to reform the management practices of the city corporation. This private venture was not profit oriented. But a question arose whether they represented the majority of the population and the poor in particular. Some scholars specifically suggested that BATF represented the urban affluent middle classes only.

154.2 Debate in the Indian Cities

In case of the local governments in Indian cities, the debate has been particularly poignant. Indian cities are facing mounting pressure to meet the needs of the growing urban corporate sector and of the new middle classes. PPPs offer a ready model for private sector participation in infrastructure-building and urban governance at this juncture. But scholars and participants have questioned whether the existing PPP strategies take into account the needs and voices of the majority of the population. (Ghosh 2006). However, the national Planning Commission, even in its latest approach paper, upholds PPPs as a good plank for urban development (See Footnote 1).

PPPs indeed present a wide and broad framework. But within this framework, there can be several models, (like BOT (Build-Operate-Transfer), BOOT (Build-Own-Operate-Transfer), LBO (Lease-Build-Operate), etc. In different models, the tasks and the risks of government and private bodies are distributed in different ways. The basic purpose of all conventional PPP models is to achieve increased amount of resource mobilization for efficient execution of projects. Private sector participation could be attracted through leasing and annuity payments. The policy conceded that private sector participation could be achieved through joint sectors projects also. If required, specific concessions and subsides could also be provided to the private investors in infrastructure development projects.

The policy insists that a private partner must be selected through a transparent process. It envisages invitation of bids—technical and financial/commercial—from among the pre-qualified firms for each project proposal. A committee of secretaries headed by the Chief Secretary reviews the PPP proposals, while the final approval to a PPP project is accorded by the Chief Minister/the Cabinet.

In the field, what was immediately apparent in the PPP initiatives of the early years of the new century was their larger size. KMDA in Kolkata in West Bengal entered into agreements with private partners for two townships, one at West Howrah, and the other at Dankuni. The West Howrah project (since described as the Kolkata West International City) was the first FDI (foreign direct investment) project in the housing sector in West Bengal, and this was also the first township in the State to be entirely handed over to a private entity on leasehold basis. The second satellite township at Dankuni is much larger than the West Howrah project in sheer size as well as in terms of other dimensions. A Delhi-based Indian giant has recently been selected through competitive bidding and the sum quoted by the winner (Rs. 2,700 crore) for this 5,000-acre township has been seen as a staggering intervention by the private sector in the real estate business of the state.

The second interesting feature has been the qualitative up gradation of some old practices and concepts. An example could be indicative. KMDA had a truck terminal on the Kona Expressway, which was suffering from several operational inadequacies. The project has since been re-packaged as a logistic hub and has been subjected to a PPP exercise. A private consortium has been selected for operating the logistic hub. This has been an interesting PPP intervention in the infrastructure sector.[2]

However, little seems to be happening in core infrastructure sectors. The Government of India in the Ministry of Finance and the Department of Economic Affairs announced a scheme for support to PPPs in infrastructure in 2005.[3] The objective of the scheme is to provide financial support to bridge the viability gap of infrastructure projects undertaken through the PPP mode. The viability gap funding is available for roads and bridges, railways, seaports and airports, urban transport projects as well as civic service projects in water supply, sewerage and solid waste management projects etc. Until now, there is no news of any project proposal sent from Kolkata or West Bengal to Delhi for this viability grant to build infrastructure in PPP modes.

154.3 PPP Initiatives

PPP Projects Status Report As on July 31, 2011 states that development and use of PPPs for delivering infrastructure services has now at least 11 years of precedence in India, with the majority of projects coming in line in the last 5–7 years. Policies in favor of attracting private participation as well as innovation with different structures have met with varying degrees of success. Some sectors like telecommunications, power, and ports and roads, have done very good progress compared to limited success in other sectors. Some states have undertaken far more PPPs than others, and there has been a much heavier use of PPPs in some sectors. As far as current status of projects is concerned, as per our database, there have been 758 PPP projects in our main sectors of focus where a contract has been awarded and projects are underway—in the sense that they are either operational, have reached construction stage, or at least construction/implementation is imminent. The total project cost is estimated to be about Rs. 383,332.06 Crore.

[2] Interview with Sri Kalyan Roy, Additional Director, Kolkata Metropolitan Development Authority, on 29 October, 2006.

[3] Government of India, Ministry of Finance, Department of Economic Affairs (Infrastructure Section), Scheme for Support to Pubic Private Partnerships in Infrastructure, New Delhi, July, 2005.

State	Total number of projects	Based on 100 crore	Between 100 and 250 crore	Between 251 and 500 crore	More than 500 crore	Value of contracts
State wise figures as on 31st July 2011						
Andhra Pradesh	96	1,484.6	2,197.8	7,062.3	56,173.7	66,918.3
Assam	4	54.0	337.2	–	–	391.2
Bihar	6	77.6	–	769.6	1,246.7	2,093.8
Chandigarh	2	75.0	–	–	–	75.0
Chattisgarh	4	70.0	304.0	464.0	–	838.0
Delhi	13	95.0	109.4	738.2	10,374.0	11,316.6
Goa	2	30.0	220.0	–	–	250.0
Gujarat	63	304.1	2,013.2	4,138.9	33,181.0	39,637.2
Haryana	10	125.0	180.0	270.0	10,588.1	11,163.1
Jammu and Kashmir	3	–	–	–	6,319.8	6,319.8
Jharkhand	9	131.0	550.0	398.0	625.1	1,704.1
Karnataka	104	1,080.4	1,942.6	13,136.3	28,499.6	44,658.9
Kerala	32	338.7	206.3	1,235.0	20,501.5	22,281.5
Madhya Pradesh	86	1,977.6	3,930.3	3,397.2	5,678.3	14,983.4
Maharashtra	78	742.3	2,988.4	2,433.7	39,427.6	45,592.0
Meghalaya	2	–	226.1	–	536.0	762.1
Orissa	27	235.1	211.0	1,473.0	11,430.6	13,349.7
Puducherry	2	–	–	419.0	2,947.8	3,366.8
Punjab	29	732.8	1,552.7	572.0	705.0	3,562.5
Rajasthan	59	633.9	783.8	1,100.8	12,508.8	15,027.3
Sikkim	24	175.6	558.0	2,669.0	13,708.0	17,110.6
Tamil Nadu	43	267.9	355.6	8,905.2	9,100.0	18,628.6
Uttar Pradesh	14	–	–	1,458.6	25,137.2	26,595.8
Uttarakhand	2	43.0	–	478.0	–	521.0
West Bengal	30	638.0	965.7	1,714.4	3,299.1	6,617.1
Inter State	14	160.5	195.0	2,474.4	6,738.0	9,567.8
Total	*758*	9,471.9	19,826.9	55,307.5	298,725.8	383,332.1
Sectorwise figures as on 31st July, 2011						
Airports	5	–	–	303.0	18,808.0	19,111.0
Education	17	424.2	365.5	460.0	600.0	1,849.7
Energy	56	337.6	934.0	3,083.0	62,890.0	67,244.6
Health Care	8	315.0	343.0	275.0	900.0	1,833.0
Ports	61	86.0	1,745.3	4,304.8	74,902.1	81,038.2
Railways	4	–	102.2	873.0	594.3	1,569.6
Roads	405	4,364.6	11,696.5	38,520.5	122,143.3	176,724.9
Tourism	50	1,132.6	1,503.5	800.0	1,050.0	4,486.1
Urban Development	152	2,812.0	3,136.9	6,688.2	16,838.0	29,475.0
Total	*758*	9,471.9	19,826.9	55,307.5	298,725.8	383,332.1

Source Public–private partnerships, India Database, Dept. of Economic Affairs, Ministry of Finance, Government of India

One-third of the municipal area in Chennai has been handed over to a private entity for conservancy activities (starting from house-to-house collection and ending at the disposal site), thereby limiting, in the process, the overhead costs of the city corporation. While the benefits of such contracting out of services may be arguable,[4] the spread of the PPP palate gets wider through such attempts. The Delhi-Noida-Delhi flyway and the Vadodara-Halol toll road in Gujarat have been seen as interesting examples of experiments with the BOOT strategy. The only case study of this type of PPP making significant progress is to be found at Tirupur in Tamil Nadu in the water sector. This type of contract is operational in a big way in the water sector in Manila, Philippines. As and when such fee-structure firmly evolves, private players may feel tempted to participate in these areas. Incidentally, the relations between user charges and PPPs constitute a central theme of the on-going urban reforms processes.

PPPs do need firm regulatory mechanisms, but the regulator will have to desist from being a partner, too. This precise segregation could well be the point of departure for tomorrow. While inaugurating a mega conference on 'building infrastructure' recently, the Prime Minister of India articulated the need for "an independent, transparent policy" with firm elements regarding regulation.

A fourth point emerges in the context of this need for regulations. It is widely acknowledged that an enabling, conducive and well-defined legal framework facilitates PPP initiatives in infrastructure. In India, Gujarat (1999) and Andhra Pradesh (2001) enacted such laws with the following underlying themes: (1) clear demarcation of roles and responsibilities of all stakeholders; (2) introduction of transparency, stability and predictability in the PPP process; and (3) outlining the various principles for infrastructure service delivery. In West Bengal, the State Government has published a policy, though it is yet to firm up a comprehensive legal framework for PPPs. But it has been rightly felt that preparation of PPP policy is not enough. It is learnt that the State functionaries consider a policy to be a creative and flexible platform to work upon, though the option of evolving a legislative framework is also under consideration.[5]

154.4 Issue of Political Philosophy

The discourses on privatisation and public–private partnerships have been dominated, since 1980s, by personalities like Margaret Thatcher, Ronald Reagan and Milton Friedman, and institutions like the World Bank and the Asian Development Bank. In India, the discussions gained momentum in the 1990s, when the Soviet

[4] Interview with Sri M. P. Vijaya Kumar, IAS, Municipal Commissioner, Chennai Municipal Corporation on 4 October, 2006. The Commissioner, during the conversation, did not appear entirely convinced about the superior result of the PPP initiative.

[5] Interview with officials of the Urban Development Department, Government of West Bengal.

bloc had collapsed and when a particular variant of globalisation became the mainstay of a unipolar world. De-control, de-licensing, de-regulation, liberalisation and privatisation became virtually synonymous. The governments, both at the centre as well as at the states, were in the abdicating mood, while the private sectors were buoyant. Public–private partnerships implied exit of governments and the public sectors from (and the entry of the private corporate sector into) governance and infrastructure building. The word “private” became interchangeable with the “corporate”.

In the process, the private citizen went missing. The organised corporate firms swallowed the entire private world, with the solitary individuals swept out of existence. There were often attempts to organise the citizens’ groups, as in the case of the Bangalore Agenda Task Force. But, on critical examination, it transpired that these groups often excluded the majority of the population, and emerged, instead, as virtually para-statal elite clubs. The virtual (or eventual) para-statal character of similar, subsequent initiatives (e.g., *Janaagraha* of Bangalore etc.,) is demonstrated by their co-option in the Jawaharlal Nehru National Urban Renewal Mission of the Government of India. Arguably, these later initiatives are also characterised by their urban middle class character. The poor and the marginal private citizens find no room in the current deliberations on PPP strategies.

154.5 Conclusion

The discourses on PPPs have dominated the discussions in many disciplines in last two decades. Political Science, public administration, management sciences and economics have been some of the disciplines which have been most influenced by PPP discourses. In the domain of practice also, the emphasis is on building houses, markets and infrastructure, rather than on building relationships with all sections of citizens. The public policies and the dominant practices refer to partnerships between government and corporate enterprises, and seldom to partnerships between government and community based organizations. Discourses on PPPs are becoming elitist and market-centric. For some time now in India, it was thought that decentralization would be the cure for many of our ailments. The solution was projected to be omnibus and inclusionary, because it attempted to accommodate both efficiency and participation. The new panacea of PPPs emphasizes efficiency, but underlines participation only selectively, to the extent that the private companies are involved. Unfortunately, the people at large find no room in the doctrine of PPP, in the way the concept-credo is being defined now in India.

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Chapter 155
Efficiency Evaluation of Industry-University-Research Institute Collaboration: A Case Study of Suzhou

Meng Dai, Chi Wang, Xiao-ran Hu and Chengyang Xie

Abstract In the government's efforts to promote technological innovation, one of the important parts is industry-university-research institute collaboration. Suzhou is the pioneering area of China's economic development, where industry-university-research institute collaboration has played a significant role in its regional development. By evaluating the efficiency of this collaboration in Suzhou and analyzing its characteristics, we can scientifically formulate the planning of the first development area-Sunan (south area of Jiangsu province), lead the transformation of the local and other regions and build the innovation-based economy. By means of the data envelopment analysis method, this paper intends to make a preliminary evaluation of the efficiency of the industry-university-research institute collaboration in each district in Suzhou.

Keywords Industry-university-research institute collaboration · Efficiency · Suzhou · Data envelopment analysis method

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M. Dai (✉) · C. Xie
Research Center for Group Economics and Industrial Organization in Southeast University, School of Economics and Management in Southeast University, Nanjing, China
e-mail: daimengmilam@126.com

C. Xie
e-mail: daimengmilam@126.com

C. Wang
School of Foreign Languages in Southeast University, Nanjing, China
e-mail: wangchi_seu@126.com

X. Hu
School of Economics and Management in Southeast University, Nanjing, China
e-mail: xiaoran_hu_2012@yeah.net

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155.1 Introduction

The industry-university-research institute collaboration (IURC) is that the enterprises, universities and research institutes (or other organizations) carry out the risk-sharing and benefit-sharing technological innovation collaboration, which is of their joint development, joint contribution, and complementary advantages, based on the development needs of enterprises and the common interests of all parties. It's aimed at enhancing the innovation capability of industrial technology under the protection of a legally binding contract.

Since Chinese government implemented the policy of reform and opening-up, the IURC began to flourish and became one of the main cooperative forms of independent innovation around the country, marked by two National Science and Technology Conferences in 1995 and 2006.

Suzhou is the forefront of reform and opening up, whose industry-university-research institute collaboration has experienced more than 30 years' development, changing from "Saturday Engineer" to "Suzhou Leading Talents." Looking back to the course of Suzhou's industry-university-research institute collaboration, the process of its development has gone through three stages[1]: "Bud," "Development" and "Prosperity." Before the year 1994, generally the firms had more initiative in participating in IURC than that of the government to promote IURC, which was the characteristic of the "Bud" stage-combination of industry, university and research institute; From 1994 to 2002, the main form of IURC is the firms' participation under the government's guidance, which was the feature of the "Development" stage, changing to the combination of industry, university, research institute and government; After the year 2002, the IURC gradually shifts to the pattern that under the guidance of the government, firms act as the main body directed by the market, which is the characteristic of the "Prosperity"-close cooperation of industry, university, research institute, government, financial institute and intermediary institute.

Looking back on the road of industry-university-research institute collaboration over the past thirty years, although Suzhou system has begun to take shape and made significant achievements, there are still some differences between the districts (county-level cities). As a result, how to promote the coordinated development of IURC has become a widely concerned problem. Therefore, it is of theoretical and practical significance to make an evaluation of the IURC in each district (county-level cities) in Suzhou.

Based on the current literature, this paper will propose the series indexes that are suitable to evaluate the IURC in the districts (county-level cities) in Suzhou. By employing the Data Envelopment Analysis (DEA) method, this paper will evaluate the present status of IURC in Suzhou and offer corresponding policy advice.

[1] Current achievement of the project "A Study of International Transfer of Industrial Clusters and the Chain Effect of Industrial Clusters in Chinese Enterprises' foreign direct investment," sponsored by the national natural science funds.

155.2 Choice of Series Indexes to Evaluate IURC

In order to make an exact evaluation of the IURC efficiency of each district (county-level cities) in Suzhou, it's necessary to build (or choose) appropriate series indexes for IURC evaluation. In current literature, there are lots of research achievements about building the IURC evaluation series indexes.

The series indexes of the IURC efficiency evaluation has been a hot problem for both academic and political circles. For example, Wang and Wang (2009) hold that the IURC efficiency can be considered from two aspects: input and output. Shen and Zhou (2010) propose that we can study three stages: pre-collaboration, mid-collaboration and post-collaboration. Huo (2009) argues that IURC can be analyzed from three dimensions: input, process and output. Xiao et al. (2009) think that IURC should be discussed at macroscopic and microscopic levels. Xia discusses how to evaluate IURC efficiency through the method of balanced scorecard.

Some scholars adopted hierarchical series indexes. For example, Cao et al. (2010) believe that the series indexes should be divided into two levels. The first level is composed of five indexes: the environment, input, operation and economic effects of the collaborative innovation. And each of these indexes contains several secondary indexes. Zhao et al. (2010) also adopts the system of the first-level and second-level indexes. Zhang and Li (2011) then choose the three-level evaluation system: target layer, rule layer and index layer. Other scholars, like Jin and Luo, also employ the hierarchical system (Furong and Shougui 2009).

In summary, these series indexes cover different contents. Some are fitted for the evaluation of the specific projects of the IURC, whereas others are appropriate for the comprehensive evaluation of the IURC in certain regions.

Based on the DEA method, this paper chooses the evaluation frame of the series indexes, which are composed of two layers-input and output. The choice of the indexes has consulted the existing literature and the data of the technology statistics in Suzhou.

From the aspect of input, this paper chooses 6 evaluation indexes: number of key laboratories, number of public technical service platform, personnel number of bachelor degree or above, number of talents for scientific and technological activities, project funds and funds of the firms' technological activities.

From the aspect of output, this paper also chooses 6 indexes: number of talents selected for the "National Thousand Plan", number of talents selected for the "Innovative or Venture Personnel in Jiangsu", number of "Suzhou Leading Talents", number of patent licensing, technology award and amount of the transaction in the market of technology (Cooper et al. 2011; Yanhu and Shiyan 2010).

On the basis of the above indexes, this paper will employ the DEA method to evaluate the efficiency of IURC in each district (county-level cities) of Suzhou.

155.3 Method of Data Envelopment Analysis

The data envelopment analysis (DEA) is used to empirically measure productive efficiency of decision making units, which was proposed by American operations researcher Charner and other researchers. It promotes the efficiency evaluation from the single-input, single-output, similar decision-making units (DMU) to multi-input, multi-output ones, which has greatly enriched the production function theory in the micro-economics and its applying techniques. Meanwhile, it has immeasurable superiority to avoid subjective factors, to simplify algorithm and to reduce the errors (Coelli et al. 2005). The unique features and advantages of DEA has received a widespread concern and quickly developed in both theoretical research and practical application. It has become one of the effective analytical tools and research methods in the fields of management science, systems engineering and decision analysis, evaluation techniques and so on.

The DEA method is mainly to evaluate the efficiency of N DMUs. Supposing that there are n DMUs and each of these has m types of inputs and s types of outputs, let's mark x_{ij} as the the inputs of the i-th input for the j-th DMU ($x_{ij} > 0$), y_{rj} as the outputs of the r-th output for the j-th DMU ($y_{rj} > 0$), v_i as the weight of the inputs and u_r as the weight of the outputs $(i = 1, 2, \cdots, m; r = 1, 2, \cdots, s;$ $j = 1, 2, \cdots, n)$.

when we evaluate the efficiency of the j_0-th $(1 \leq j_0 \leq n)$, the weight coefficient v and u are the variables and the efficiency index of j_0-th DMU is the target. We can construct the C^2R model shown in formula (155.1) (for convenience, this paper notes (x_{j_0}, y_{j_0}) as (x_0, y_0)).

$$\left(P_{\overline{\mathbf{c^2R}}}\right)\begin{cases} max\ \dfrac{u^T x_0}{v^T y_0} \\ s.t.\dfrac{u^T x_j}{u^T x_j} \leq 1, j = 1, 2, \cdots, n, \\ v \geq 0, \\ u \geq 0. \end{cases} \tag{155.1}$$

Based on the above method, the definition of DEA efficiency is:

1. If the optimal solution of the linear programming (P_{c^2R}) ω^0, μ^0 satisfy:

$$\mu^{0T} y_0 = 1, \text{ and } \omega^0 > 0, \mu^0 > 0.$$

Then DMU j_0 is weak DEA efficiency.

2. If the optimal solution of the linear programming $(P_{c^2R})\omega^0, \mu^0$ satisfy:

$\mu^{0T} y_0 = 1$, 且 $\omega^0 > 0, \mu^0 > 0$
Then DMU j_0 is DEA efficient.

with the definition of efficiency, we can judge DMUs' efficiency through solving the model.

155.4 The Efficiency Evaluation of Iurc in Suzhou Based on the Dea Method

According to the above series indexes and efficiency evaluation method, the DEA method can be applied to evaluate the efficiency of IURC in the districts (country-level cities) in Suzhou. The data of inputs are shown in the Table 155.1 and the data of outputs are shown in the Table 155.2. The main data in the two tables about the districts (country-level cities) in Suzhou are from the "Science and Technology Statistical Compendium of Suzhou."

1. On the assumption that the scale benefit is constant, the relative efficiencies of IURC in each district (country-level cities) are as follows:

By substituting the data of the above tables into the DEA model (155.1), and applying the software MaxDEA5.2 to solve it, we can get the IURC innovative efficiency value $\theta$of each district (country-level cities) in Suzhou. Table 155.3 gives the relative efficiency value and slack variables of inputs and Table 155.4 is about the relative efficiency value and slack variables of outputs.

The Table 155.3 and Table 155.4 show that eight districts (or country-level cities) are DEA efficient, which are Changshu, Kunshan, Taicang, Wujiang, Wuzhong, Xinqu, Park area, Zhangjiagang. Each of them has the relative efficiency value $\theta = 1$ and slack variables $s- = 0$, $s+ = 0$, showing that all of the inputs and outputs are in the best conditions. The relative efficiency values of Chengqu and Xiangcheng are respectively 0.86 and 0.97, both of which are below 1, showing that the two DMUs are DEA inefficient and input surplus or output shortage exists.

For areas of inefficient DMU, one or more input indexes have non-zero slack variables, which are the factors that restrict the efficiency of the IURC. The non-zero slack variables of the input indexes represent the redundancy of an input index relative to the projection of the effective frontier, and the non-zero slack

Table 155.1 Output table of the districts (country-level cities) in Suzhou in 2010

District	Key laboratory	Public service technology platform	Talent of bachelor degree or above	Talent of scientific and technological activity	Project funds (ten thousand Yuan)	Funds of firms' technological activity (one hundred million)
Zhangjiagang	1	8	82	5,765	5,439	8.72
Changshu	1	8	776	4,934	3,886	9.98
Kunshan	4	8	1975	24,437	10,070	80.83
Taicang	0	5	191	3,350	1,559	9.26
Wujiang	1	4	276	16,330	4,570	25.87
Wuzhong	5	18	632	3,821	4,761.4	5.49
Xiangcheng	1	5	140	2,795	1,365	4.46
Park area	33	17	8,134	19,668	30,795.3	30.45
New area	6	18	2,721	19,553	12,701	30.29
Chengqu	50	36	1,205	780	12,511.6	0.99

Table 155.2 Output table of the districts (Country-level cities) in Suzhou in 2010

District	National thousand plan	Innovative or venture personnel in jiangsu	Suzhou leading talents	Patent licensing	Technology award	Transaction in the market of technology (one hundred million)
Zhangjiagang	0	11	6	3,049	21	0.82
Changshu	0	7	4	4,242	10	1.35
Kunshan	6	25	19	10,750	19	2.08
Taicang	0	7	7	2,602	1	3.61
Wujiang	2	2	5	14,698	13	0.01
Wuzhong	0	5	4	3,567	9	0.91
Xiangcheng	0	3	2	1,625	4	0.32
Park area	11	51	62	3,014	16	11.52
New area	7	18	22	2,269	9	2.46
Chengqu	0	0	0	293	0	0.30

Table 155.3 Relative efficiency value and slack variables of inputs in the districts (country-level cities) in Suzhou

District	θ	s_1^-	s_2^-	s_3^-	s_4^-	s_5^-	s_6^-
Changshu	1	0	0	0	0	0	0
Urban area	0.86	49.85	35.01	1168.70	365.67	12227.45	0
Kunshan	1	0	0	0	0	0	0
Taicang	1	0	0	0	0	0	0
Wujiang	1	0	0	0	0	0	0
Wuzhong	1	0	0	0	0	0	0
Xiangcheng	0.97	0.79	2.64	78.85	472.55	0	0.13
New area	1	0	0	0	0	0	0
Park area	1	0	0	0	0	0	0
Zhangjiagang	1	0	0	0	0	0	0

Note the indicators of slack variables in this table rank the same as Table 155.1 (The data are kept to two decimal places.)

Table 155.4 Relative efficiency value and slack variables of outputs in the districts (country-level cities) in Suzhou

District	θ	s_1^+	s_2^+	s_3^+	s_4^+	s_5^+	s_6^+
Changshu	1	0	0	0	0	0	0
Urban area	0.86	0	0.77	0.74	0	0.36	0
Kunshan	1	0	0	0	0	0	0
Taicang	1	0	0	0	0	0	0
Wujiang	1	0	0	0	0	0	0
Wuzhong	1	0	0	0	0	0	0
Xiangcheng	0.97	0.10	0	0.39	0	0	0.45
New area	1	0	0	0	0	0	0
Park area	1	0	0	0	0	0	0
Zhangjiagang	1	0	0	0	0	0	0

Note the order of indicators and data type in this table are the same as Table 155.3

variables of the output indexes represent the shortage of an output index relative to the projection of the effective frontier (Linfeng and Li 2010). Based on the calculation of the slack variables, we could analyze how to adjust the inefficient DMUs' IURC.

Urban area has output shortage of indexes in National Thousand Plan, Provincial Innovative or Venture Personnel in Jiangsu and Suzhou Leading Talent. When inputs are constant, the shortages of the three indexes are 0.77, 0.74 and 0.36. On the other hand, urban area has redundancy in inputs of the number of the key laboratories, the number of public technical service platform, the personnel number of bachelor degree or above, the number of scientific and technological activities talents and the project funds (Zhanxin 2010). When outputs are constant, the redundancies of the three indexes are 49.85, 35.01, 1,168.70, 365.67, and 12,227.45.

Xiangcheng has output shortage of indexes in National Thousand Plan, Suzhou Leading Talent and the funds of the firms' technological activities. When inputs are constant, the shortages of the three indexes are 0.10, 0.39 and 45 million. On the other hand, Xiangcheng has redundancy in inputs of the number of the key laboratories, the number of public technical service platform, the personnel number of bachelor degree or above, the funds of the firms' technological activities and the funds of the projects. When outputs are constant, the redundancies of the three indexes are 0.79, 2.64, 78.85, 472.55, and 13 million.

2. Three types of IURC efficiency in Suzhou and their scale benefits.

Similarly, by substituting the original data into the DEA method, we can get the result of the three types of IURC efficiency shown in Table 155.5.

Table 155.5 shows that all the DMUs except Chengqu and Xiangcheng are in the effective condition in the aspects of technological efficiency and scale benefit (Wang and Yaoming 2011). And all the DMUs are in the effective condition in terms of pure technological efficiency. Moreover, except that Chengqu and Xiangchegn are on the stage of increasing returns to scale, the other DMUs are on the stage of constant returns to scale.

Table 155.5 IURC efficiency and scale benefit in the districts in Suzhou

District	Technological efficiency	Pure technological efficiency	Scale benefit	Returns to scale
Changshu	1	1	1	Constant
Urban area	0.86	1	0.86	Growing
Kunshan	1	1	1	Constant
Taicang	1	1	1	Constant
Wujiang	1	1	1	Constant
Wuzhong	1	1	1	Constant
Xiangcheng	0.97	1	0.97	Growing
New area	1	1	1	Constant
Park area	1	1	1	Constant
Changshu	1	1	1	Constant

Note the data are kept to two decimal places

155.5 Conclusions

Based on the existing literature, this paper chooses series indexes of efficiency evaluation, which are suitable for Suzhou's IURC, and employs DEA method to evaluate the efficiency. Through analysis, this paper has found that at the macroscopic level Suzhou city has made significant achievements in IURC. As for the districts (country-level cities) in Suzhou, except urban area and Xiangcheng, their DMUs have reached the DEA efficient conditions. However, from the perspective of absolute volume of input and output, there is still room for improvement for several DMUs which have reached the DEA efficient conditions. The two DMUs which have not reached the DEA efficiency are in the state of increasing returns to scale. There is still much to be enhanced, which requires us to properly regulate the input resources and output capacity and strive to achieve the DEA efficient condition.

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Chapter 156
Research on Benefit Distribution Model of Industry Technology Alliance

Bin Dai

Abstract This paper has conducted a comparative analysis on basis of existing distribution patterns of industrial technology alliance firstly, and then has constructed a benefit distribution model of industrial technology alliance based on "royalty payment pattern". At last, the paper has tested reasonableness of the benefit distribution model through the example analyses. The main contribution of the paper is expanding study of benefit distribution model from "two members" to "multiple members".

Keywords Industrial technology alliance · Fixed payment · Royalty payment · Mixed payment · Benefit distribution model · Game theory

156.1 Introduction

Since "The guidance about promoting the construction of industrial technology innovation strategy alliance" issued jointly by the ministry of science and technology, education and other six departments in December 2008, industrial technology innovation strategy alliance (referred to as "industrial technology alliance" in this paper) has gradually become an important organizational form in industrial technology innovation activities in China. Industrial technology alliance usually faces greater risks due to "the nature, objectives, and cultural diversity between different members", "opportunistic behavior", "uncertainty operation environmental" and etc., The survey data by McKensey also confirmed that

B. Dai (✉)
School of Business, China West Normal University, Nanchong, China
e-mail: daibin_2001@163.com

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alliance risk is common (Das and Teng 1998). Against that background, the special research on risk prevention and control problems of industry technology alliance is very necessary.

Because alliance member for more benefit through joining the alliance, so the key of effective prevention and control alliance risk is constructing a scientific benefit distribution model in the alliance and distributing benefits reasonably according to the model. Scholars at home and abroad has conducted some related researches, such as: Dong-chuan and Fei (2001), Zhang et al. (2001, 2002), Chen et al. (2002), Luo and Lu (2001), Wang and Kou (2004), Lei (2008) and Guardiola et al. (2007). But the above researches limited to only two members in an alliance. Because of this, we will try to build an benefits distribution model which suitable for more members in an alliance by using related theories such as "game theory", so as for theoretical support to the practice of industry technology alliance benefit distribution.

156.2 Benefit Distribution Patterns of Industry Technology Alliance Analysis and Choice

When distributing benefits in cross organization like strategic alliance, we usually have three patterns, such as "royalty payment", "hybrid payment" and "fixed payment" (Yang et al. 2008). Every distribution pattern above all has its advantages and disadvantages, and the specific as is shown in Table 156.1.

According to above analysis results and the actual situations, this paper decides to construct benefit distribution model based on "royalty payment pattern".

Table 156.1 Advantages and disadvantages of three distribution patterns

	Advantages	Disadvantages
Fixed payment pattern	Simple and easy to operate	Difficult to reflect "risk and benefit sharing" principle, can't stimulate non-core members
Royalty payment pattern	Embody the "risk and benefit sharing" principle, play effective incentive on alliance members	Difficult to determine scale coefficient of benefit distribution reasonably, and difficult to quantify the contributions of alliance members
Mixed payment pattern	Avoid the capital pressure of initiators brought by fixed compensation mode, bound initiators and general members together	Complicated relatively

156.3 Building Benefit Distribution Model of Industrial Technology Alliance

156.3.1 Basic Assumption

Assumption 1: n ($n \geq 2$) members in an industrial technology alliance, and they are equal status.

Assumption 2: the total cost of alliance includes two parts, the materiality and the immateriality (intangible costs), and can be expressed as:

$$C_i = C_{i0} + C_{i1},\ (i = 1, 2, \ldots, n) \tag{156.1}$$

In (156.1), C_{i0} means material costs, such as alliance working capital, tangible assets and intangible assets discount etc.; C_{i1} means immaterial cost, and it relates the effort levels of alliance member i (Yang et al. 2008).

Assumption 3: C_{i1} is positively correlated of the effort levels of alliance member i, and also increasing speed up along with the efforts increasing. According to above assumption, immaterial cost C_{i1} of alliance member i can be expressed as:

$$C_{i1} = \alpha_i e_i^2 \tag{156.2}$$

In (156.2), α_i ($\alpha_i \geq 0$) means immaterial cost coefficient of the alliance member i, e_i means the effort level of alliance members participating in the alliance.

Assumption 4: the relative contribution coefficient of alliance member notes for β_i, which decided by the relative importance of resource which be putted into the alliance cooperation by alliance members.

Assumption 5: Profit available for distribution of the alliance decided by e_i and β_i, the specific function relations between them can be expressed as:

$$R = (\beta_1 e_1, \beta_2 e_2, \cdots, \beta_n e_n) = \sum\nolimits_{i=1}^{n} \beta_i e_i + \theta \tag{156.3}$$

In (156.3), θ means exogenous random variables, such as the influence of "market fluctuations" for the distribution benefits; θ obeys the normal distribution.

Assumption 6: if the distribution coefficient of alliance member i notes for S_i ($\sum\nolimits_{i=1}^{n} S_i = 1$), the distribution benefits notes for R_i, so that:

$$R_i = S_i * R \tag{156.4}$$

156.3.2 Model Building and Solving

According to the "economic man hypothesis", the ultimate goal of the alliance should be "overall profit of alliance maximization" in making benefit distribution scheme of industry technology alliance. However, it must take "the individual profit maximization" as the prerequisite because the existence of "bounded rationality" (Zhang et al. 2009). Based on the above analysis, this paper confirmed the mentalities about constructing Alliance benefits distribution model: firstly, to construct alliance members individual profit maximization model, and determine the level of alliance members e_i^*; Secondly, take e_i^* into the corresponding formulas to construct the overall profit maximization model, and solve initial distribution scale coefficient S_i of the alliance members; Finally, adjust to determine the final distribution benefits ratio $S_{i(adjuxt)}$ through internal consultation mechanism in the alliance.

1. Individual profit maximization model building and solving

According to relevant mathematical knowledge, we can build the individual profit maximization model, as follows:

$$\begin{cases} \max E(\pi_i) = E(R_i) - C_i \\ s.t. E(\pi_i) \geq \pi_{i\ 0}, \quad i = 1, 2, \ldots n \end{cases} \tag{156.5}$$

Among them: π_{i0} is the minimum profit of the alliance member i, if the profits of member i below π_{i0}, member i will choose to quit alliance.

Take (156.1), (156.2), (156.3), (156.4) into (156.5), get the expected profits for the members i, as follows:

$$E(\pi_i) = E(R_i) - C_i = S_i * \sum\nolimits_{i=1}^{n} \beta_i e_i - C_{i0} - a_i e_i^2$$

Use $E(\pi_i)$ to $e_i (i = 1, 2, \cdots, n)$ for a derivative:

$$\partial E(\pi_i)/\partial e_i = S_i \beta_i - 2a_i e_i$$

Make $\partial E(\pi_i)/\partial e_i = 0$, so $S_i \beta_i - a_i^2 e_i = 0$, get:

$$e_i^* = S_i \beta_i / 2a_i \, (i = 1, 2, \cdots, n - 1)$$

When i = n,

$$e_n^* = \left(1 - \sum\nolimits_{i=1}^{n-1} S_n\right) \beta_n \Big/ 2a_n$$

Above calculation results show that: when effort level of the members i is e_i^*, the members i achieved individual profits maximization.

2. Overall profit maximization model building and solving

According to relevant mathematical knowledge, we can build maximization model for alliance overall profit, as follows:

$$\begin{cases} \max E(\pi) = E(R) - \sum_{i=1}^{n} C_i & \\ s.t. E(\pi_i) \geq \pi_{i0}, & i = 1, 2, \cdots n \\ e_i = e_i^*, & i = 1, 2, \cdots n \end{cases} \tag{156.6}$$

Take (156.1), (156.2), (156.3), (156.4) into (156.6), we can get the expected profits of the whole alliance:

$$E(\pi) = \sum\nolimits_{i=1}^{n} \beta_i e_i - \sum\nolimits_{i=1}^{n} C_{i0} - \sum\nolimits_{i=1}^{n} a_i e_i^2,$$

Use $E(\pi)$ to $S_i (i = 1, 2, \cdots n)$ for a partial derivative:

$$\begin{cases} \dfrac{\partial \pi}{\partial S_1} = \dfrac{\partial \pi}{\partial e_1} \cdot \dfrac{\partial e_1}{\partial S_1} = \left(\beta_1 - 2a_1 e_1\right) \cdot \dfrac{\beta_1}{2a_1} - \left(\beta_n - 2a_n e_n\right) \cdot \dfrac{\beta_n}{2a_n} \\ \dfrac{\partial \pi}{\partial S_2} = \left(\beta_2 - 2a_2 e_2\right) \cdot \dfrac{\beta_1}{2a_2} - \left(\beta_n - 2a_n e_n\right) \cdot \dfrac{\beta_n}{2a_n} \\ \cdots \\ \dfrac{\partial \pi}{\partial S_{n-1}} = \left(\beta_{n-1} - 2a_{n-1} e_{n-1}\right) \cdot \dfrac{\beta_{n-1}}{2a_{n-1}} - \left(\beta_n - 2a_n e_n\right) \cdot \dfrac{\beta_n}{2a_n} \\ \dfrac{\partial \pi}{\partial S_n} = \left(\beta_n - 2a_n e_n\right) \cdot \dfrac{\beta_n}{2a_n} \end{cases} \tag{156.7}$$

Take $e_i^* = S_i \beta_i / 2a_i$ (i = 1, 2, … , n − 1) and $e_n^* = \left(1 - \sum_{i=1}^{n-i} S_n\right) \beta_n / 2a_n$ into (156.7), order it 0, we can see:

$$\begin{cases} -\dfrac{\beta_1^2}{2a_1} \cdot S_1 + \dfrac{\beta_n^2}{2a_n} S_n = -\dfrac{\beta_1^2}{2a_1} + \dfrac{\beta_n^2}{2a_n} \\ -\dfrac{\beta_2^2}{2a_2} \cdot S_2 + \dfrac{\beta_n^2}{2a_n} S_n = -\dfrac{\beta_2^2}{2a_2} + \dfrac{\beta_n^2}{2a_n} \\ \quad \cdots \\ -\dfrac{\beta_{n-1}^2}{2a_{n-1}} \cdot S_2 + \dfrac{\beta_n^2}{2a_n} S_n = -\dfrac{\beta_{n-1}^2}{2a_{n-1}} + \dfrac{\beta_n^2}{2a_n} \\ S_1 + S_2 + \cdots + S_{n-1} = \frac{1-\beta_n}{\beta_n} \end{cases}$$

Above equations can be converted into:

$$\begin{bmatrix} -\frac{\beta_1^2}{2a_1} & 0 & \cdots & \frac{\beta_n^2}{2a_n} \\ 0 & -\frac{\beta_2^2}{2a_2} & \cdots & \frac{\beta_n^2}{2a_n} \\ \cdots & \cdots & \cdots & \cdots \\ 0 & & -\frac{\beta_{n-1}^2}{2a_{n-1}} & \frac{\beta_n^2}{2a_n} \\ 1 & 1 & \cdots & 0 \end{bmatrix} \cdot \begin{bmatrix} S_1 \\ S_2 \\ \cdots \\ S_{n-1} \\ S_n \end{bmatrix} = \begin{bmatrix} -\frac{\beta_1^2}{2a_1} + \frac{\beta_n^2}{2a_n} \\ -\frac{\beta_2^2}{2a_2} + \frac{\beta_n^2}{2a_n} \\ \cdots \\ -\frac{\beta_{n-1}^2}{2a_{n-1}} + \frac{\beta_n^2}{2a_n} \\ \frac{1-\beta_n}{\beta_n} \end{bmatrix} \tag{156.8}$$

From (156.8), we can get S^* for:

$$S^* = \left[S_1^*, S_2^*, \cdots, S_n^*\right]^T = \begin{bmatrix} -\frac{\beta_1^2}{2a_1} & 0 & \cdots & \frac{\beta_n^2}{2a_n} \\ 0 & -\frac{\beta_2^2}{2a_2} & \cdots & \frac{\beta_n^2}{2a_n} \\ \cdots & \cdots & \cdots & \cdots \\ 0 & & -\frac{\beta_{n-1}^2}{2a_{n-1}} & \frac{\beta_n^2}{2a_n} \\ 1 & 1 & \cdots & 0 \end{bmatrix}^{-1} \cdot \begin{bmatrix} -\frac{\beta_1^2}{2a_1} + \frac{\beta_n^2}{2a_n} \\ -\frac{\beta_2^2}{2a_2} + \frac{\beta_n^2}{2a_n} \\ \cdots \\ -\frac{\beta_{n-1}^2}{2a_{n-1}} + \frac{\beta_n^2}{2a_n} \\ \frac{1-\beta_n}{\beta_n} \end{bmatrix} \tag{156.9}$$

3. Deciding ultimate benefit distribution coefficients

The above quantitative analysis determined the initial distribution benefits scale coefficients of alliance members. It should transit the negotiate mechanism in the alliance to adjust initial scale coefficient on the base of quantitative analysis, so as to determine the final alliance benefit distribution ratio, notes for S^*_{adjust}.

$$S^*_{adjust} = \left[S_1^* + S_{10}, S_2^* + S_{20}, \cdots, S_n^* + S_{n0}\right]^T$$

Among them: $S_{i0}(i = 1, 2, \cdots, n)$ means benefit distribution ratio of alliance members, and $\sum_{i=1}^{n} S_{i0} = 0$.

4. Example analysis

Next, the example analysis is for the inspection of reasonableness of industrial technology alliance benefit distribution model. For the sake of simplicity, this

Table 156.2 Simulation parameter values of alliance benefit distribution in the model

α_1	α_2	β_1	β_2
0.62	0.56	0.6	0.4

paper takes only two members in the case as an example. The parameter values of benefit distribution model in this example analysis are as shown in Table 156.2.

Take data in Table 156.2 into (156.9) respectively, the calculation of available:

$$S_1 = \frac{\alpha_2 \beta_1^2}{\alpha_1 \beta_2^2 + \alpha_2 \beta_1^2} = \frac{0.56 * (0.6)^2}{0.62 * (0.4)^2 + 0.56 * (0.6)^2} = 0.67,\ S_2 = 1 - S_1 = 0.33$$

With the negotiate mechanism in the alliance to adjust the initial scale coefficient, it determines scale coefficient as (0.6, 4) eventually.

156.4 Conclusion

Because alliance member for more benefit through joining the alliance, so the key of effective prevention and control alliance risk is constructing a scientific benefit distribution model in the alliance and distributing benefits reasonably according to the model. In view of this, This paper comparatively analyses the existing distribution model firstly, and with "royalty payment mode" as the foundation constructs benefit distribution model of industrial technology alliance, and at last, verifies its reasonableness through the example analysis. The study shows that the benefit distribution coefficient of alliance member (S^*) decides by the immaterial cost coefficient (α_i) and the relative contribution coefficient (β_i). The main contribution of this paper is developing the corresponding research to the alliance situation of "members more than two", thus for this constructed model more close to the benefit distribution practice of industrial technology alliance.

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Chapter 157
Industry Standard Modular Innovation Trap: Causes and Avoiding Strategies

Jun Liang

Abstract Many scholars only see the positive role of the modular innovation network to the industry-standard innovation and ignore the existence of modular innovation trap. In fact, the latecomer companies often easily fall into the trap of modular innovation. The reason is the companies do not recognize the essence of the modular innovation networks, cannot handle the monopoly, competition and cooperation relationship between their own, the systems integrator and other module suppliers. For the module with a relative disadvantage technical capabilities must adjust its innovation strategies, correctly handle the competition and cooperation relationship with other module suppliers, and on the basis of that, compete and cooperate with the system integrators and effectively avoid the trap of modular innovation.

Keywords Industry standards · Modular innovation · Latecomer companies · Trap · Avoid strategies

157.1 Introduction

In recent years, modular and modular innovations was applied to many occasions including the industry standard innovation, how to promote the latecomer companies integration into the modular innovation to enhance their innovation efficiency had become a hot research topic. The existing studies only see the positive role of the modular innovation networks bring to the latecomer companies and ignore the fact that the modular networks easily form modular innovation trap and its negative effect to the latecomer. This paper describes the modular trap, analyze the root of the modular innovation trap, and propose some strategies to avoid it.

J. Liang (✉)
Business School of Shandong University,
No.180 West Culture Road, Weihai 264209, China
e-mail: liangjunsong@sdu.edu.cn

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157.2 Formation of the Industry Standard Modular Innovation Networks

In the knowledge economy and information economy, the manner which how to handle the information and knowledge within the economic system will directly affect the system innovative capacity and global competitiveness. Modular as an effective method to treat complex systems was applied to more and more occasions, to enhance the modularity of the system has become a general strategy to manage complex things (Langlois 2002). The so-called module is semi-self-regulating subsystems, and in accordance with certain rules is linked together to the other subsystem and forms a more complex system or process. Modular innovation firstly decompose the original innovation chain in the traditional linear innovation model, and then integrate them together. Through the innovative modular decomposition, the module has the "information package" feature, that is, according to the "public information", their innovation is independent and dispersed without disturbing each other, and any organization can be used as an innovation module get into each innovation node, including the innovative integration link. Under the coordination of public information different innovative modules is interconnected to form a modular innovation network, the core of the modular innovation is to integrate knowledge.

Modular innovation network based on industry-standard is a agglomeration which interrelated businesses and organizations form in the virtual space, in order to integrate and develop global market, and enhance global competitiveness of the whole network, it is network-based, use modern communications and information technology as the main means of communication and exchange, its main content is to make, lead, develop and use the industry standards. This kind virtual space agglomeration whose elements are industry technical standards replace the geographical proximity with the organization close (Zhu 2004), after encoding the knowledge and information that the industry-standard technologies involved in, make them cross geospatial global transmission and cooperation, and thus can effectively link and integrate the global innovation resource.

157.3 Latecomers is Easy to Fall Into the Industry Standard Modular Innovation Trap

In the modular networks, the developing countries are locked in a subsidiary and peripheral lower-end. In the modular network whose the highest demand is system integrators interests, if the developing countries want to popularize their industry standards, participate in global standards innovation and competition, implement industrial upgrading, they will encounter not only the ruthless suppression and obstacles of the system integrators (Liang 2007), but industry-standard modular innovation trap.

First of all, the system integrators which have more advantage at the industry-standard innovation and their developed countries gain more benefit from the modular innovation network. (a) The contract manufacturing service providers in the developed countries often obtain the most interests from the high-tech enterprises outsourcing strategy. These contract manufacturing services have strong supply chain management and technical advantages, form a close contact, quick response production system in the world, pose a great threat on supplier-led upgrade strategy of the developing countries (Wang 2011). (b) In modular mode, the small and the start-up companies in the developed countries are easier to enter into the industry high-end such as making industry standards and innovation. In contrast, if the developing countries with lower level of knowledge and technology in general want to study and gain the core modules technical knowledge and other information, because of the "information package" feature of the module, can only direct acquire the necessary modules through merger, research and development, or the intellectual property and patents "glued" on it. Unfortunately, since a variety of political obstacles, policies and regulations, national consciousness and the trade unions and other "non-economic factors", making cross-border mergers hide a huge risk (Liu 2009). (c) These leading enterprises, which have been able to control the industry rules and design standards need less venture invest for the capital-intensive production processes, they can rely on their skills, knowledge and talent advantage, rapidly put their autonomous, has not been code-based knowledge and technology into new industries, firstly carry and lead leading design or industry standard of the emerging industries, and thus also vacillate in many different industries, rather than trapped in any one kinds of individual downstream consumer goods.

Secondly, the latecomer companies are often locked in the innovation low-end, their most work is to repair and consolidate the existing industry standards and consolidation, their patents is often a peripheral rather than core paten and they often carried out "support innovation" instead of "disruptive innovation". (a) When suppliers have invest all of the specific investment including all of equipments and links needed by a finished products production, and their destiny will be locked together with this specific product, it is often doomed, although they will be innovative, but often only peripheral non-core innovation, their fundamental starting point is to improve the performance of goods to meet consumer demand, they will instinctively reject those new technologies and ideas which may completely replace the existing product. These actions actually defend and strengthen the systems integrator's core interests. (b) The leading companies in the modular innovation networks often adopt a variety of strategies to deal with the challenge of the standard competitor. Among them, the "parts brand" strategy makes users regard particular brand as a very important factor in the assessment element as people purchase and evaluate the product function and quality, and ultimately continue to strengthen the control of the core companies to the industrial chain; implementation of the "integrate standard, patents and intellectual property" makes technical standards become a private resources and a control competitive tool, the patent owner use the patent to expand patent interests to the entire range of technical standards, and thus control the entire industry (Li 2007), further strengthen and expand the standard-setter's monopoly profits (Zhang 2008); "continuously assimilate and integrate the periphery innovation" increasingly expand the functions range of the core technology, at the same time, continue to squeeze the space created by the periphery innovation and the added value, and rapidly increasing the threshold that high-links access to market, further consolidate its core position of the leading industry-standard.

157.4 Cause of the Formation of Modular Trap

Integrators build, maintain and operate the modular innovation network, their fundamental purpose is to strengthen their own core competencies and monopoly. Integrators utilize innovative leadership and the strong market monopoly position, relying on the global network, decompose the innovation chain into different links and contract to different companies, integrate their own innovation ability in full range by modular thinking, and through the "cascade effect" (Nolan et al. 2006) conduct the operating pressure of the core competency modular to other participating companies in the network, attract more outstanding enterprises to participate in the modular innovative and network and dynamically make a choice, communicate and collaborate with their own innovation resources and capabilities, thereby break the organization's physical and geographical boundaries, utilize the supplies core competency advantage of the global innovation networks to enhance their innovative function, obtain the leverage effect of the innovation competency, strengthen and consolidate their own monopoly position.

The cause of the modular innovation traps is that module supplies as a latecomer companies don't understand the essence of the modular innovation networks when they merge in it, therefore, cannot correctly handle the relationship of the monopoly, competition and cooperation with system integrators and the other module suppliers, competition and cooperation. It mainly embody as follows.

First, module suppliers simply pandering to the integrator strategic arrangement, they emphasis too much on their dependence on integrators and ignore their own competency autonomy development. Latecomers in the process of integration into the modular network don't sight the mutual beneficial cooperation need and urgency between the module supplier, compete with each other to meet and adapt to the need and arrangement of the system integrators in the monopoly position, make their operation highly modular, implement the so-called "refocusing strategy", willing to act as a low-end modular supplies, under the industry standard "surveillance", engaged in labor and natural resources intensive work of the organization processing and assembly industries, gain pitiful meager profits. Their innovation often is support innovation rather than disruptive innovation to repair and maintain the established industry standards. These excessively competition will eventually lock module suppliers in the modular trap.

Second, module suppliers often emphasis too much on their survival and development independence in the modular innovation network and ignore their capabilities complement and the need for cooperation with the other module suppliers. The core companies which at any moment can feel a variety of innovative competitive pressures inside and outside the network, they have been seeking and implementing strategic measures to consolidate and strengthen their leading position. Among these strategies, rapidly increase the core module technology integration is the most powerful strategic response. For example, in the era of picture tubes television have five core chip, in the flat-panel TV age, the number of core chips become two or one (Song 2008). By putting the original five-chip functions into two chips to improve the integration of the core chip, the global leader again make Chinese companies far behind them which in the era of color TV tubes had formed their core technical capabilities. When the product technology becomes integration again from the modular, the relationship between the various components will be extremely complex, the product system does not exist standard rules, the product cannot be divided by the uniform rule. At this time, if the companies at the disadvantage of the technology and knowledge refuse cooperation with the other companies within the product internal division, then this excessive "independence" will make they be bound in the past technology paradigm and development path, it is difficult to separate from the established product technology framework and break the monopoly of the incumbent control, the knowledge, hard work and the huge investment to explore and develop new product often come to naught, ultimately these companies are fallen into modular innovation trap.

157.5 Strategy to Avoid the Modular Trap

In modular age, the company competition is become into the network competition, the competitiveness of companies depends on whether the company merge into the modular network and their own understanding and adapting to the network (Cao et al. 2008). Therefore, the module suppliers at a relative disadvantage of the technical ability should correctly the relationship of the competition and cooperation with the other module suppliers, and on this basis, develop innovative competition and cooperation with integrators.

First, module suppliers should deeply dig local market, consolidate the existing "modular" core competencies, at the same time, broaden the scope of value chain management, cultivate products framework capacity based on local market. In the process of the industry standard innovation, although the leader will try to suppress, hinder development and combat the latecomer, they cannot seize all of the market opportunity, establish their own global standards in all the emerging strategic industries. Chinese companies should deeply dig the local market, accurately understand and grasp of the local base on the product function and characteristics required by the local market, merge in much more local elements and re-definition the product. To cultivate and develop the product framework capacity based on the local market is the important starting point for Chinese companies to participate in the global competition of the industry standards innovation.

Second, the related module suppliers in the product value chain should collaborate with each other, actively respond to the monopoly suppression of the core companies to enhance the core components integrated degree. MP3 as a digital product is a good example, most important components within MP3 is the main chip, it is integrated by the MP3 decoder chip, MCU (microprocessor), interface control chip and the operation control circuit. The solution of the higher chip technical barriers, China's domestic companies adopt a vertical and horizontal collaboration manner, different enterprises are located in different nodes of MP3 value network. Finally, in the MP3 route tends to integrated design conditions, China's domestic companies are still able to occupy different value network nodes though the open organizational structure, give a strong fight back to the pressure of the leading companies to enhance the degree of core component integration, obtain remarkable result of the domestic MP3 70 % market shares.

Third, the upstream and downstream of the value chain should closely cooperate to build their own standard innovation networks in order to participate in global competition, access to industry standard-setting power. In 2003, Lenovo, TCL, Konka, Hisense and Great Wall, co-sponsored and established "IGRS" 3C collaborative standards consortium, then continue to expand to the industry chain's upstream and downstream, achieve vertical integration of the industrial chain, enhance the Alliance's manufacturing capacity, research capacity and product technology integration degree and "IGRS" standard industrial applications, and successfully create a standard innovation network including chip manufacturing, software development, network operations, product manufacturing, knowledge innovation and many other modules. On this basis, "IGRS" union began to directly compete with DHWG alliance composed by Intel and Microsoft companies and other standard innovation network in 3C industry collaborative standards. After five years of hard work, in 2008, "IGRS" series of testing and certification standards were recognized by the International Standards Organization ISO, this standard has been the first 3C collaborative standards adopted by ISO.

157.6 Conclusion

Modular innovation can effectively enhance the industry standards innovation efficiency and global competitiveness. Modular innovation network, in essence, is the organizational platform for system integrators to strengthen their core competencies and monopoly position. When latecomer companies merge into the modular innovation network and participate in industry-standard modular innovation, they must understand the essence of the modular innovation networks, correctly handle the relationship of the monopoly, competition and cooperation with systems integrators and other module suppliers and adapt their industry standard competition strategies in order to effectively avoid the trap of the modular innovation and improve innovation efficiency.

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Chapter 158
Effect of Foreign Direct Investment on Industrial Innovation: An Empirical Research on the Equipment Manufacturing Industry in China

Xu-sheng Chen, Hong-qi Wang and Yun Zhong

Abstract With the advent of globalization, foreign direct investment (FDI) became an important means for a host country to obtain advanced technology and management experience. This paper analyzes the influence of FDI on industrial innovation in the equipment manufacturing industry in China. First, the study establishes a corresponding evaluation index system according to FDI factors affecting industrial innovation. Second, the paper demonstrates the performance of the main FDI factors through scores obtained from super-efficient data envelopment analysis (DEA), and distinguishes the degree of the effects of different factors through composite DEA. The results show that the intensity of market entry of FDI is the most significant factor in industrial innovation, whereas the impact of the technology spillover effect of FDI is the least significant. Finally, the study suggests countermeasures to improve FDI performance in industrial innovation.

Keywords Effect · Equipment manufacturing industry · Industrial innovation · Super efficiency DEA

158.1 Introduction

As the largest developing country in the world, in order to optimize the industrial structure, enhance the level of the product technology and expand the international trade cooperation, China needs to have a leap-forward development in capital, technology and management, which is difficult to realize by only relying on the innovations of the domestic enterprises in a short period of time. Learning

X. Chen (✉) · H. Wang · Y. Zhong
School of Management, Harbin University of Science and Technology,
Harbin, China
e-mail: xtdllw@163.com

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and absorbing the foreign experience and technologies can accelerate the late-development advantage of China.

During 1979-2008, the total amount of FDI in China reached nearly $900 billion. The foreign investment changed our market structure. Due to the externality and spillover effect of technology, FDI can promote technological innovation by the inter-firm linkages (Marin and Costa 2010). The advanced technologies and management modes not only brought the competitive pressures to China's enterprises but also became the object to be imitated (Mingfeng and Carolin 2011).

The existing literatures mostly study the overall effect of FDI on innovation (Yan-Qiu et al. 2007), however hardly has research with analyzing the effects of different factors in FDI on innovation efficiency of Chinese equipment manufacturing industry. The research of the influence of the innovation investment, entry intensity, as well as scientific and technological activities on innovation can further define the mechanism of action of FDI in promoting the industrial innovation and provide the basis for the formulation of FDI policies.

FDI is widely adopted by the multinational companies as an important means to expand the global market and reduce costs. In 2004, the FDI of the U.S. multinational companies increased by 90 % (Anon 2005). With the transmission of information and the reduction of goods transportation costs, FDI driving force is gradually shifting to the technical factors. According to the findings of the U.S. multinational-owned R&D lab, its main purpose is to obtain the human capital for science and technology (Florida 1997). And the developing countries also have begun to develop the policies of taking advantage of the foreign-invested companies to promote the development of the national high-tech fields (Joseph and Michael 1999). Evidence of Irish also shows that the number and R&D activities of the foreign-invested enterprises in the high-tech fields have become the driving force of economic growth (Allan and Frances 2001). With the intensifying competition, the multinational companies are also increasing their R&D investment in the host countries. According to Kuemmerle's detailed investigation of the labs established by 32 large multinational companies in five countries, the R&D investment by the foreign-funded companies has greatly exceeded that over the past 40 years (Walter 1999). As the technology spillover effect of FDI is becoming increasingly evident, FDI has become the independent and complementary innovation system to the national innovation system, which promotes the relevant researches to attract increasing attention.

Through the analysis of the panel data of China's manufacturing industry during 1998 and 2003, it can be learnt that the diversity of FDI is conducive to the technology spillovers (Yan et al. 2010). In the manufacturing industry, market competition, labor mobility and the degree of openness of the industry are the key factors that affect the technology spillovers (Zhang et al. 2008). And the research of FDI in the developed areas in China shows that high technological ability can increases the region's capacity of attract foreign investments (Yufen and Jin 2009). Owning the advanced technology and high human capital is an important factor to increase the FDI spillover effect. FDI always produces the positive technology spillover effect on the domestic enterprises in the same industry, especially when these enterprises are in the same area, but the adverse impact on the domestic enterprises in other industries (Xiaowen and Shuanglin 2009).

The size of FDI in the host country decides its overall effectiveness, market influence and ability to avoid the risk and facilitates the technology spillover effects. Angelo pointed out according to the empirical studies in Brazil that the policy makers in emerging markets should try to stimulate its domestic market to attract foreign direct investment rather than adjusting the fiscal and monetary policies (Angelo et al. 2010). The decisive factor of attracting FDI in China is the market size, department distribution, labor, transportation infrastructure, etc. Dang Jun explained with the application of game model that China's implementation of the fair anti-dumping measures would not be affected by the FDI size in the long time (Jun et al. 2010). In addition, the lower the cultural differences and efficient government have contributed to the expansion of FDI scale (Brouthers et al. 2008).

158.2 Methodology

1. *Performance Evaluation Based on SE-DEA*: DEA model have two kinds of forms, one is fractional programming, and the other is the linear programming. The two forms are equivalent, the former is obtained by ratio definition, and the latter is based on a series of production formula assumption. Based on the formula assumption of convexity, coning and invalidity, we can get the following DEA model:

$$
\begin{array}{lll}
(M1)\ \min\theta - \varepsilon \sum\limits_{r=1}^{t} S_t^- - \sum\limits_{j=1}^{n} x_{ij}\lambda_j = 0 & & \\
\qquad x_{ij_0}\theta - S_i^- - \sum\limits_{j=1}^{n} x_{ij}\lambda_j = 0 & i = 1, 2, \cdots m & \\
s.t. \quad -S_r^+ + \sum\limits_{j=1}^{n} y_{rj}\lambda_j = y_{rj_0} & r = 1, 2 \cdots t & \\
\qquad \lambda_j, S_t^-, S_r^+ \geq 0 & \forall j, r, i &
\end{array}
\tag{158.1}
$$

According to the discussion about oriented input DEA model (M1) above, we can see the basic idea of the DEA is that finding out the effective frontier from the envelope surface formed by data. (M1) is a constant return to scale DEA model, when adding the constraint $\sum \lambda_j = 1$, which based on the formula assumption of the convexity, coning and invalidity, we can get the following DEA model (BCC model) which meet the scale benefits variable. (M1) can be transferred into an equivalent fractional programming model:

$$(M2) : \max h_0 = \sum_{r=1}^{t} u_r y_{rj_0} \Big/ \sum_{t=1}^{m} v_t x_{tj_0}$$

$$s.t. \sum_{r=1}^{t} u_t y_{rj} \Big/ \sum_{t=1}^{m} v_t x_{tj} \le 1 \qquad j = 1, \cdots, n$$
$$u_t, v_t \ge \varepsilon, \forall r, i \tag{158.2}$$

Similar to (M1), we can get the DEA model (M3) oriented output optimization.

$$\begin{aligned} &(M3)\ \max\varphi - \varepsilon\sum_{r=1}^{t} S_r^+ - \varepsilon\sum_{t=1}^{m} S_t^- \\ &\quad \varphi y_{rj_0} + S_r^+ - \sum_{j=1}^{n} y_{rj}\lambda_j = 0 \qquad r = 1, 2, \cdots, t \\ &s.t.\ S_t^- + \sum_{j=1}^{n} x_{tj}\lambda_j = x_{tj_0} \qquad j = 1, 2 \cdots, m \\ &\quad \lambda_j, S_t^-, S_r^+ \ge 0 \qquad \forall j, r, i \end{aligned} \tag{158.3}$$

CCR DEA model can not be adopted to distinguish efficient DMU which value of θ is 1. SE-DEA model can overcome the disadvantages of CCR mode (Jun et al. 2010), since the unit's relative placement regardless of its efficiency can be calculated, and the model can be expressed as follows:

$$\begin{cases} \min\left[\theta - \varepsilon([e^-]^T s^- + [e^+]^T s^+)\right] = V_D \\ s.t \sum_{\substack{j=1 \\ j \ne j_0}}^{n} \lambda_j X_j + S^- = \theta X_0 \\ \sum_{\substack{j=1 \\ j \ne j_0}}^{n} \lambda_j Y_j - S^+ = Y_0 \\ \lambda_j \ge 0, j = 1, 2, \cdots n \\ S^+ \ge 0, S^- \ge 0 \\ [e^-]^T = [1, 1, \cdots, 1]^T \in E^m \\ [e^+]^T = [1, 1, \cdots, 1]^T \in E^n \end{cases} \tag{158.4}$$

2. *Index Comparison Based on Composite DEA*: There are n DMU, they have the types of input m, s types of output, $x_i(i = 1, \ldots, m)$ is to show the input of i class, $y_r(r = 1, \ldots, m)$ is to show the output of the r class, said the target system with D,

$$D \triangleq \{x_1, \cdots, x_m, y_1, \cdots, y_s\}$$

Remove the first species with *di* said output indicator set. Refers to the use of in *di* DEA method, find the effectiveness of various policy unit of coefficient vector obtained $\theta(D_i)$, $\theta(D_i) = (\theta_1(D_i), \ldots, \theta_n(D_i))^T, (i = 1, \ldots, \tau)$, and can prove that $\theta(D) \ge \theta(D_i)$.

For the invalid DMU, the input index which affects its performances value can be studied, firstly, Invalid vectors $\theta(D_{j0})$ should be calculated, thus, new vectors that $S_i = (\theta_{j0}(D) - \theta_{j0}(D_i))/\theta_{j0}(D_i)$ is defined, For total influence on invalidation of DUM is computed according to (158.5), the index which has bigger influence score regard as main factor.

$$\sum S_i = \sum (\theta_{j0}(D) - \theta_{j0}(D_i)) * 100/\theta_{j0}(D_i) \tag{158.5}$$

3. *Setting up evaluation indexes*: According to the DEA model, the paper establishes the index system of inputs and outputs, there is four input indexes, which are personnel input of FDI on scientific and technical (X_1), organization activities of FDI on science and technology (X_2), intensity of market entry of FDI (X_3), and technology spillover effect of FDI (X_4).

   The input formulas are expressed as followed.

X_1 personnel engaged in S&T activities of joint ventures (unit: person);
X_2 projects for S&T activities of joint ventures (unit: item);
X_3 gross industrial output value of joint ventures/gross industrial output value;
X_4 expenditures for in draught of technology of joint ventures + expenditures for absorb and digest of joint ventures + expenditures for inner technology of joint ventures (unit: 10,000 Yuan).

There are two output indexes, which are the ability to develop new technology (Y_1), level of profit of new product (Y_2).

The output formulas are expressed as followed.

Y_1 patent applications in industrial enterprises (unit: item);
Y_2 gross industrial output value of new products in industrial enterprises (unit: 10000 Yuan);

4. *Data source*: The data of empirical research are taken from China Statistical Yearbook and China Statistical Yearbook on Science and Technology (2009); according to sample requirement of DEA model, 28 industry of manufacturing industry have been selected, and data of sample is listed in Table 158.1.

Moreover, Other Countries have not proposed the concept of equipment manufacturing industries except China. This paper defined former industries which include DUM21 to DUM27 in Table 158.1. Because of the monopoly position of the Chinese manufacture of tobacco, FDI is very little in manufacture of tobacco, and its impact can be ignored, so the samples get rid of manufacture of tobacco.

158.3 Results

158.3.1 Result of Efficiency by CCR DEA

Scores and rank of efficiency by CCR DEA is listed in Table 158.2.

Table 158.1 DUM of manufacturing industry

DUM	Industry
1	Processing of food from agricultural products
2	Manufacture of foods
3	Manufacture of beverage
4	Manufacture of tobacco
5	Manufacture of textile
6	Manufacture of textile wearing apparel, foot ware and caps
7	Manufacture of leather, fur, feather and its products
8	Processing of timbers, manufacture of wood, bamboo, rattan, palm, straw
9	Manufacture of furniture
10	Manufacture of paper and paper products
11	Printing, reproduction of recording media
12	Processing of petroleum, coking, processing of nucleus fuel
13	Manufacture of chemical raw material and chemical products
14	Manufacture of medicines
15	Manufacture of chemical fiber
16	Manufacture of rubber
17	Manufacture of plastic
18	Manufacture of non-metallic mineral products
19	Manufacture and processing of ferrous metals
20	Manufacture and processing of non-ferrous metals
21	Manufacture of metal products
22	Manufacture of general purpose machinery
23	Manufacture of special purpose machinery
24	Manufacture of transport equipment
25	Manufacture of electrical machinery and equipment
26	Manufacture of communication, computer, other electronic equipment
27	Manufacture of measuring instrument, machinery for cultural and office work
28	Manufacture of artwork, other manufacture

158.3.2 Result of Efficiency by SE-DEA

Scores and rank of efficiency by SE-DEA are listed in Table 158.3.

158.3.3 Result of Index Comparison Based on Composite DEA

The efficiency scores of DUM by composite DEA are listed in Table 158.4; $\theta(D_i)$ represent the efficiency scores of remove i index. Sum of changed ratio $(\sum S_i)$ is listed in Table 158.5 according to (158.5), which comparison to equipment manufacturing industry (DUME).

Table 158.2 Result of efficiency by CCR DEA

DUM	Scores	Rank	DUM	Scores	Rank
DUM1	0.3230	26	DUM15	0.6009	19
DUM2	0.4692	21	DUM16	0.2472	27
DUM3	0.3696	25	DUM17	0.7511	16
DUM4	1.0000	1	DUM18	0.6047	18
DUM5	0.4215	22	DUM19	1.0000	1
DUM6	0.3952	24	DUM20	0.9419	9
DUM7	0.8867	11	DUM21	0.8884	10
DUM8	1.0000	1	DUM22	0.8443	12
DUM9	0.2255	28	DUM23	1.0000	1
DUM10	0.3974	23	DUM24	0.7734	14
DUM11	1.0000	1	DUM25	1.0000	1
DUM12	1.0000	1	DUM26	0.7560	15
DUM13	0.6483	17	DUM27	0.8272	13
DUM14	0.4870	20	DUM28	1.0000	1

Table 158.3 Result of efficiency by SE-DEA

DUM	Scores	New rank	DUM	Scores	New rank
DUM4	1.4056	4	DUM19	3.6134	1
DUM8	1.3705	5	DUM23	1.0985	7
DUM11	2.1689	2	DUM25	1.3833	6
DUM12	2.0875	3	DUM28	1.0176	8

158.4 Discussion

Through the calculation of efficiency value of the equipment manufacturing industry, the results show that the efficiency value of manufacture of special purpose machinery (DUM23) and manufacture of electrical machinery and equipment (DUM25) all reached 1; while the efficiency value of the other five industries is between 0.7 and 0.9, and is located in the top fifteen in manufacturing industry.

As CCR DEA method cannot distinguish the industry with efficiency DUM which efficiency value is 1, so we make adjustment for each sample in forefront surface with SE-DEA according to saving situation of input elements, and the efficiency value not reaching 1 remains the same score. After calculation by SE-DEA, the efficiency value of manufacture of electrical machinery and equipment marks the highest, namely, 1.3833, followed manufacture of special purpose machinery whose efficiency value is 1.0985.

Through analyzing and calculating FDI factors which influence the innovation efficiency of equipment manufacturing industry, the scores of composite DEA show that the intensity of market entry pose the most crucial influence on

Table 158.4 Changed efficiency scores by composite DEA

$\theta_{j0}(D_i)$	X_1	X_2	X_3	X_4
DUM1	0.2894	0.3230	0.2783	0.3168
DUM2	0.3105	0.4692	0.3974	0.4692
DUM3	0.2985	0.3696	0.3206	0.3628
DUM4	1.4056	1.3635	1.0112	1.2571
DUM5	0.4215	0.3941	0.3926	0.3733
DUM6	0.3952	0.3412	0.3952	0.2460
DUM7	0.8258	0.8867	0.8297	0.8785
DUM8	1.3666	1.1201	1.3705	1.1606
DUM9	0.2255	0.1530	0.2255	0.2255
DUM10	0.3974	0.3696	0.3587	0.3260
DUM11	2.1689	2.1689	2.1689	0.8542
DUM12	2.0875	2.0875	2.0875	0.7952
DUM13	0.6172	0.6483	0.4673	0.6483
DUM14	0.4870	0.4870	0.3439	0.4593
DUM15	0.6009	0.4482	0.6009	0.4597
DUM16	0.2221	0.2472	0.2226	0.2431
DUM17	0.7511	0.7511	0.5567	0.3359
DUM18	0.6047	0.4989	0.4872	0.6047
DUM19	3.5133	3.6134	1.6523	3.5130
DUM20	0.9419	0.7467	0.9419	0.9419
DUM21	0.8884	0.8738	0.8254	0.8262
DUM22	0.8443	0.8029	0.5398	0.8443
DUM23	1.0745	1.0985	0.7472	1.0985
DUM24	0.7734	0.7734	0.4598	0.7734
DUM25	1.3833	1.3833	0.6433	1.3783
DUM26	0.7560	0.6872	0.4445	0.7560
DUM27	0.5867	0.8223	0.6522	0.8272
DUM28	0.8077	1.0176	0.9644	1.0176

Table 158.5 Sum of changed ratio

$\sum S$	X_1	X_2	X_3	X_4
DUME	43.2275	17.4340	391.1913	7.8939

industrial innovation, and the second index is personnel input of FDI on scientific and technical, while the technology spillover effect of FDI ranks the weakest influence on industrial innovation.

158.5 Conclusion

Based on calculations using super-efficient DEA, the impact of FDI is found to be different in the equipment manufacturing industry. The difference of the efficiency value between the minimum and maximum is 0.6273. Eight industries have efficiency values reaching 1, the proportion of which in the total manufacturing industry is 28.57 %. The equipment manufacturing industry and other manufacturing industries account for 7.14 and 21.43 % of the total.

The manufacture of electrical machinery and equipment has the highest efficiency value because of the lower input and higher output requirements. The efficiency value of manufacturing communication, computer, and other electronic equipment (DUM26) is the lowest. Although the output indicators of patent applications and the gross industrial output value of new products in all manufacturing industries are high, the corresponding input index in FDI, which includes personnel input on scientific and technical processes, organization activities on science and technology, intensity of market entry, and technology spillover effect, is also high, resulting in its lowest efficiency value.

According to the efficiency value from the composite DEA of the equipment manufacturing industry and to the sum of the change ratio of influential elements, the intensity of FDI entry into the market has the most significant effect on industrial innovation. Therefore, the government should keep an active policy on foreign inventions and attract capital. At the same time, enterprises should pay more attention to the quality of foreign capital and the possibility of spillover effects brought by foreign capital, while focusing on investment projects that are scientifically and technologically innovative, thoughtful of the ecological environment, and are resource saving.

The technology spillover effect of FDI has the weakest influence on industrial innovation in the equipment manufacturing industry. The result indicates that the capacity of domestic enterprises to receive advanced technology is weak. Such finding is consistent with the actual situation in China, wherein foreign investments limit the spread of high-end equipment in the country. Enterprises should actively build a market competition environment to support technology transfer, lessen their technological and managerial gap with foreign enterprises, and make effective use of the spillover effect of R&D investment and knowledge in production.

Personnel input and organization activities relating to scientific and technical aspects of FDI have relatively weak influence on the equipment manufacturing industry partly because intellectual property rights laws in China are weak, making foreign enterprises reluctant to set up scientific research institutions in the country. The innovation ability of domestic enterprises is low, and the market lacks competition. Hence, joint venture enterprises need not introduce the most advanced technology. Clearly, China should strengthen its protection of intellectual property rights, enhance the independent innovation ability of its domestic enterprises, and encourage multinational companies in the country to increase investments on high technology.

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Chapter 159
Over-Education, Knowledge Unemployment and Economic Growth

Jun Liang, Yang Zhou and Jiao Cai

Abstract Scholars believe that both over-education and knowledge unemployment will produce unfavorable effects on economic growth, but most of them ignore that the interaction of over-education and knowledge education will also imperil economic growth. The over-education and knowledge unemployment coexist and interweave with each other at present in China, which have produced an adverse impact on labor productivity and economic growth. In order to promote economic growth and eliminate the coexistence of over-education and knowledge unemployment, it is necessary to deepen education reform, improve education system, and at the same time introduce relevant policies and measures, such as to speed up the development of service industry in order to avoid over-education and knowledge unemployment worsen.

Keywords Over-education · Knowledge unemployment · Economic growth

159.1 Introduction

Since implementing the admissions policy to enlarge the higher education scale, the students' scale of China higher education has expanded rapidly: it increases from 7.423 million in 1990 to 1.05 million in 2010. The gross entrance rate for

J. Liang (✉) · Y. Zhou · J. Cai
Business School of Shandong University, No. 180 West Culture Road, Weihai 264209, China
e-mail: liangjunsong@sdu.edu.cn

Y. Zhou
e-mail: youngera.2008@163.com

J. Cai
e-mail: yiyi_388@qq.com

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higher education exceeded the elite education threshold, which is 15 %, in 2002, and with a steady rising, it reached 26.5 % in 2010, which indicates China has officially entered the popular education stage (Zhou 2005). But subsequently college student employment becomes austere, the graduation even means unemployment for many college students and the wage level has been general reduced. Some scholars prove that the relationship between the expansion of higher education and economic growth is not always positive correlate by empirical research (Jiang 2002). Based on these phenomena, some scholars believe that China already has a common over-education problem, namely there is a big gap between education development level and the social economic development level due to excessive education investment. However, other scholars, who hold knowledge unemployment theory, disagree on that. In their opinions, Chinese problem is the knowledge unemployment other than over-education, generally speaking, knowledge unemployment is an inevitable product due to the increase of the education level in developing countries, and only when the education level of individual is higher than work-needed education level. Can it be called over-education. Besides, over-education usually exists in developed countries, Since China is a developing country whose education is in deepening stage at present and is still far below the over-education level. For all these reasons, China has not appeared over-education yet (Xiang and Wang 2006). we think over-education and knowledge unemployment coexist and interweave in China currently and produce great influence on Chinese economy, neither over-education nor knowledge unemployment could describe the situation comprehensively, so it is not helpful to understand the problems precisely and completely and also not contribute to find the real "key" to solve the problems from the respect of either over-education or knowledge unemployment (Duncan and Hoffman 1981).

159.2 The Coexistence and Interaction of Over-Education and Knowledge Unemployment

Over-education theory was first proposed in 1976 by the U.S. Labor economists R. B. Freeman, and it was used to explain the fall in education yields of United States since the early 1970s. Freeman pointed out that the inflated expectations on future labor market made the higher education labor supply, whereas the increased labor force could not be absorbed by the labor market matched with the education level, thus the higher education workers occupied the jobs of low level technology workers (Freeman 1976). Henry Levin (Henry M. Levin, 1985) defined three specific measuring standards of over-education in detail: (a) after being educated, the worker's economic status drops compare to the higher level worker in history; (b) educated people fail to meet the expectations of career success; (c) workers have higher education skills than its work demanded (Tsang and Levin 1985). However, the above three measuring standards are too general to be operated in practice, so scholars continue to develop other theories to measure the degree of the over-education. Among these theories, the groundbreaking research on over-education posted by Greg Duncan and Saul Hoffman provided an correct thinking way to study this problem for successors, that is, before further measuring over-education, we must measure the work demanded education. The methods to measure demanded education can be roughly divided into the work analysis method, the worker self-assessment method, the actual matching method and so on (Sheng 2004).

As for the cause of over-education, scholars give theoretical explanations from different point. Considering from the perspective of economic analysis, there are Human Capital Theory and the Screening Hypothesis. Human Capital Theory first defines an ideal labor market, namely an completely competitive market without system obstacle, transaction costs and incomplete information. In this market, labor supply and demand depends only on changes in wage rate, over-education is a temporary phenomenon appears in incomplete labor market. The education investment return will affect the individual's investment in education, when education is excessive, the labor wage rate will fall and lead to a decline of return on investment in education, this avoids the excessive investment in education. Therefore, education and job will match each other in the long term. Moreover, this theory believes that the real labor market does not meet the assumptions of completely competition is another reason why over-education are produced, and lead to the job seekers could not always find jobs that match their education level in labor market (Alba-Ramirez 1993).

Unlike Human Capital Theory, Screening Hypothesis explains the cause of over-education from the perspective of employing units. According to this theory, as the external manifestation of personal basic information, education plays a role of screening device to help employers to identify and find the demanded employee and decide wage, occupation distribution and assignment when they have difficulty in obtaining their comprehensive information. Consequently, in order to obtain a good job more easily, job seekers have to improve the education level constantly. But with the expansion of the scale of higher education, there are more and more highly educated holders whereas the job supply has only changed a little in labor market, and employing unit has more and more demanding on job seekers. Therefore, under the same work requirements condition, the labor education level has a relative upward trend, which means the appearance of over-education phenomenon (Spence 1990).

Knowledge unemployment is a state that highly educated workers are not employed. It can be expressed as the modernized talents cultivated by higher education have a larger amount than the jobs the modern sector can accommodate. As a result, part of knowledge workers cannot find jobs. Strictly speaking, knowledge unemployment is an economic phenomenon between voluntary unemployment and involuntary unemployment, it is a embarrassing situations in which the job seekers cannot find a higher post but unwilling to take a lower one relative to their expectation. Actually, as long as the job seekers adjust their employment mentality and career anchors a little, they can still find ordinary jobs.

After all, these knowledge workers are younger, educated, and have a strong ability to accept new things (Li 2005).

Generally speaking, knowledge unemployment is affected by the following factors: (a) oversupply of knowledge labor force. This can usually be linked to above-mentioned over-education theories as the over-education extremely likely will contribute to the knowledge unemployment in the short run; (b) structural asymmetry of supply and demand. We usually ascribe this to unreasonable setting of university majors, and education contents and cultivated goal departure from the market needs (Jiang 2004); (c) analysis based on the job search and its extension model indicates that knowledge workers regard knowledge unemployment as a waiting unemployment. According to the Signal Transmission Theory, a person's work experience will transmit signals about his or her ability to employers in the next job hunting, thus most knowledge workers are unwilling to condescend to those unsatisfactory jobs (Lai and Tian 2005); (d) the economic system arrangement maybe has the potential influence on the knowledge unemployment, (Shao and Hu 2006).

Knowledge unemployment theory and over-education theory have different emphasis: knowledge unemployment mainly indicates the unemployment of higher educated labor force with a structural surplus, while over-education involves not only the higher education graduates can't find work smoothly, but also the mismatch between the education level of employee and the education level the job required, which shows as an overall surplus. It can be said that the knowledge unemployment is a necessary stage of education deepening process, while over-education appears only when a country's national education reaches a certain level as a whole in the strict sense. However, the over-education and knowledge unemployment coexist with each other at present in China. Over-education cannot happen overnight, it needs a development process, so whether a country has entered the universal education stage (gross entrance rate for higher education $> 50\ \%$) or not cannot be taken as the only necessary condition for it. Besides, the education levels and supply and demand status for labor market are various in different areas in China. For the top-tier cities like Beijing, Shanghai, labor supply exceeds demand, which is more likely the overall surplus rather than just structural surplus. Facing the unbalanced development situations, we believe that the knowledge unemployment has become a common phenomenon, and the over-education has appeared in local region at the same time.

159.3 Impact on Economic Growth

Both knowledge unemployment and over-education will affect economic growth, but considered separately, over-education has more negative impacts on economic growth due to its wider influence. As knowledge unemployment is the result of structural surplus in some modern sectors, its negative influence on economic growth is not very serious relatively. In the reality, knowledge unemployment always interacts with over-education, and affects economic growth together.

159.3.1 The Interaction of Over-Education and Knowledge Unemployment may Cause "Adverse Selection" in Education Investment and a Huge Waste in Human Capital

First of all, over-education and knowledge unemployment may promote each other, and dim education signal, trigger education investment adverse selection behavior. According to Screening Hypothesis, as a screening device of labor market, education degrees not only decide whether the job seeker could get jobs successfully or not, but also will affect the future salary and post arrangement, and this will drive some educated to chase highly education degrees in order to get better jobs. In addition, we should realize that quite a part people with higher education continue their education not because they want to or they hope to get a higher education degree to proof their ability, but because they have to as they do not have any advantage in talent market competition, it is a kind of adverse selection. Therefore, knowledge unemployment may promote over-education and adverse selection, and the over-education and adverse selection will make unemployment knowledge more serious.

Second, knowledge unemployment and over-education will cause a huge waste of human capital undoubtedly. Generally speaking, apart from the opportunity cost or other costs, cultivating a college student will cost country and family about 5–8 million RMB even if just calculate college education investment. Knowledge unemployment and over-education will reduce the return on education investment, so some poor families maybe reduce or even terminate the education investment. Even if the well-off families who blindly pursue the higher education degree increase the education investment, their other family consumption will be influenced inevitably. Moreover, unlike physical capital, human capital cannot be stored, any unnecessary leave-unused is a kind of value waste. Considering the limitation of national financial resource, the education resources, especially the higher education resource, is allocated in proportion of the national economy development, thus the waste of investment in education will inevitably affect other development of society, and further may make China's real growth rate far lower than the potential economic growth rate. Furthermore, we should know that either knowledge unemployment or over-education is a unstable factor in society, it is easy to bring about the public anxiety and social instability, after all, going to university has always been the main way to improve economic conditions and to achieve higher social status situation for ordinary people in China. If knowledge unemployment and over-education cannot be solved, more and more knowledge labor will join the team of unemployment, and as a result, people and families will have an uncertain pessimism on the future and be discontented with society. In addition to that, it also gives a great psychological pressure on employees, and the expansion of unemployment scale will cause social instability, too.

159.3.2 Over-Education has a More Serious Effect on Economic Growth than Knowledge Unemployment as it will Cause "Lemon Effect"

Firstly, over-education has a more serious effect on economic growth than knowledge unemployment, over-education includes not only the current dominant unemployment but also the unemployment of job hunters with low education degree because the high education degree holders occupied their position. Besides, the mismatch of education level and post makes them prone to produce a psychological gap because of the failure in meeting their expectation on careers, therefore over-education has a wider negative influence on economic growth, and it mainly shows as followings: over-education may let employees get a attitude and inimical behavior which is not conducive to the improvement of labor productivity. The studies of Simon Kuznets have shown that, the high GNP growth rate of developed capitalist country is not primarily determined by the growth of labor or capital input, but is determined by the substantial growth in labor productivity, so if the labor productivity could not be improved to an appropriate level, a burden on economic growth will come into being.

Secondly, over-education may also generate lemon effect in high-end employment market. The lemon effect mainly emphasizes that when we treat education degree as a screening device, its signal function has the possibility to be distort due to the existence of adverse selection. In the first place, the job-seekers can be divided into over-educated and job-matched educated, we can prove that, in an oversupply labor market, people who has low ability are often more likely to be over-educated and to get a better job because of the opportunity cost. Because compared with the high ability, people with the low ability is more difficult to find a education-matched job under the education-matched condition, so these people have more motivated to accept over-education while the people with the high ability has a greater opportunity cost to give up a ideal job to continue education. Eventually, the education degree signal as the personal capacity of job seekers will be distorted. When these low ability over-educated graduates enter into the labor market, the supply will further exceed the demand, the employers are always in a advantage position and are very likely to reduce the starting salary of the recruitment. At this time, the high-ability candidates will lose enthusiasm to apply the jobs because of the dissatisfaction with starting salary. However, considering their own conditions and the opportunity cost without the jobs, the low-ability candidates tend to accept the lower conditions given by employers. As a result, the low-ability applicants will have more competitive advantages than the high-ability applicants, then the lemon effect (bad money drives out good) phenomenon appears in high-end employment market and produces adverse effects on social economy development. This is because the quality and capacity of the employment in high-end labor force market who are the main body of knowledge innovation, is the key to improve labor productivity and economic growth (Zhang 2007).

159.4 Countermeasures

In view of the coexistence of over-education and knowledge unemployment currently in China, we think we should take appropriate measures to alleviate their negative impacts on economic growth firstly, we must break the interrelated chain between knowledge unemployment and over-education. Certainly, we should proceed in an orderly way and step by step so as not to affect China to achieve its goal of becoming a strong human resources nation. According to the above analysis, we can reduce the negative influence of knowledge unemployment and over-education on economic growth from the following two aspects:

First of all, we should reform and improve the education system, optimize education resource allocation. (a) The government should guide and improve the current education system, increase investment in education, and the investment should tilt to the private universities and vocational and technical colleges which have finance shortage problems. Only in this way, can the financial pressure of related schools be reduced. And it might contribute to solve the "enrollment thirst disease" of these schools, too. Moreover, we should integrate the existing education resources and concentrate these resources on building a number of world advanced key universities at the same time (Yang 2004). On the one hand, we should encourage knowledge workers to start their own business by making preferential policies in the aspect of credit, land, tax revenue and so on. On the other hand, we should give students more advices to improve their prediction ability, reduce their job expectation, and build a correct self-employed value and employment value. (b) Universities should figure out the supply and demand situation in the labor market of each major, timely adjust the majors' direction and teaching plan, set up majors that society demanded and cancel the obsolete courses at the same time. In order to help students to meet the job-application requirements, the universities should try their best to strengthen practice teaching, enhance students' abilities of practical operation and business management and improve the way they treat people and things. It is also important for universities to do a good job in employment guidance, so that they can help students adapt to the changing requirements of society and satisfy the needs of choosing careers or establishing businesses. Furthermore, setting up their own businesses can not only make entrepreneurs employed, but also can provide jobs for society. (c) The knowledge workers not only need to adjust their mentality and to cope with harsh reality of knowledge unemployment actively, but also need to adjust their employment expectations according to the change in supply and demand situation of labor market.

Secondly, we should accelerate the development of high-end services, absorb more well-educated labor force, avoid the further deterioration of knowledge unemployment, thereby slowing down and cut off the knowledge unemployment and over-education intertwined, vicious spiral roots. Under the current economic circumstances, the government should publish corresponding policy to accelerate the high-end service industry development to reduce or even eliminate the over-education phenomenon. A typical characteristic of service industry is its huge capacity for labor force. From the respect of employment quantity, the amount that China's service industry absorbed has increased most rapidly compare to the first and the second industry since 1978. According to the National Bureau of Statistics, the average growth rate of labor force in service industry from 1978 to 1996 is 7.6 %, while the rates of the primary industry and the industry are 1.6 and 5.0 % respectively. In 1990s, when the average growth rate of labor force in the primary industry had a negative growth (−1.8 %) and the second industry had a slow growth (3.0 %), the service industry still maintained a growth rate of 7.6 %. This fully shows that the services industry has become the main industry to absorb labor force in China (Xue and Han 2006). But in general, the employment structure of China's service industry is still not reasonable, the financial industry and the science and technology industry only make up a small share, and compared with the developed countries, there is still a big difference. The government should introduce relevant policy to rationalize the service structure, and to absorb excessive labor force to mitigate the negative impact of over-education and knowledge unemployment exert on economic growth.

159.5 Conclusion

At present, over-education and knowledge unemployment are coexistence in China, simply divide this phenomenon into over-education or knowledge unemployment isolated cannot describe the current situation comprehensively, it is not helpful to grasp the problems precisely and completely, and it is difficult to find the real key to solve the problems correctly. In order to eliminate over-education and knowledge unemployment, we should recognize the profound impact that the interaction of over-education and knowledge unemployment produces. What's more, only to deepen education reform, improve education system, optimize allocation of education resources and in the meanwhile to introduce relevant policies and measures, such as to speed up the development of service industry to eliminate the source of coexistence and interaction between knowledge unemployment and over-education fundamentally, can the problem be solved eventually and thus to promote the sustained growth of economy.

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Chapter 160
The Advantage of Using the Electric Vehicles

Yue-ying Yang, Di Liu, Jun Meng, Xu Li, Ting-ting Shang and Jian-xin Hu

Abstract With the rapid development of the electricity, the advantage of using the electric vehicles has become more attractive than before. Firstly, to prove the emission of carbon dioxide and the consumption of fossil fuels have been reduced, we establish a time series prediction model. The result indicates that the spread of electric vehicles not only does good to the environment but also makes good impact on the economy. Secondly, in order to provide a model of the amount and type of electricity generation, by comparative analysis, we searched out the perfect interval of various kinds of energy sources, adequately satisfy the demands of the government and all social circles. To insure safe, efficient and effective transportation, the introduction of widespread use of electric vehicles becomes a necessary trend. Hence, the development of electric vehicles must go through a zigzag road and be full of challenges.

Keywords Consumption of fossil fuels · Electric vehicles · Energy · Time series model

Y. Yang (✉)
Postdoctoral Programme, Northeast Forestry University,
Harbin, China
e-mail: yangyueying2008@yahoo.com.cn

Y. Yang · D. Liu
Postdoctoral Programme, Heilongjiang Academy of Agricultural Sciences,
Harbin, China

Y. Yang · J. Meng · X. Li · T. Shang · J. Hu
Department of Information and Computation Science,
Northeast Agricultural University, Harbin, China

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160.1 Introduction

With the development of society, the widespread use of electric vehicles has become a necessary trend (Wada 2009; Stone et al. 2009). As a new kind of transportation means it makes influences on various aspects, aspects such as environment, society, economy, and health (Huo et al. 2010; Keefe et al. 2008; Melaina and Webster 2011; Jacobson et al. 2005; Pietikainen et al. 2009). Both the government and the manufacturer should take these key factors into consideration carefully when determining whether and how to support the development and use of electric vehicles (Abolhasani et al. 2008; Merrild and Christensen 2009; Stocker 2008; Zhai et al. 2009). Collect the data and establish models. On the basic of the model(s) established above, we attempt to estimate how much fossil fuels would be saved in the world by widely used electric vehicles. Set up a model about the amount and type of electricity generation which should be added to meet your model, which, not only benefit the environment, society, business, and individuals in maximum limit but also calculate the amount and type of electric vehicles being used (Frey et al. 2009; Caduff et al. 2010; Choi and Frey 2010; Graver et al. 2011). Write a detailed report to present your model and your analysis of the key issues associated with the electric vehicles and the electricity generation, including the strategies the government apply to insure safe, efficient and effective transportation. Also, you should think whether it is worth bringing in electric vehicles or not, besides, discuss the impact it makes on global energy needs in the face of dwindling fossil fuel supplies.

160.2 Methodology

With electric vehicles' widespread use, more and more other kinds of energy have been changed to electric energy for electric vehicles, As a matter of fact, the amount of fossil fuel which burns directly for vehicles reduces..There will be pollution when the fossil fuel transforms or burns. CO_2 emission changes most obviously, so we choose CO_2 emission as the index to represent for the environment. In the opinion of the manufacturer, they do like to produce electric vehicles if most consumers like to buy, because of the profit. Questionnaire has been used to find out if consumer groups are satisfied with electric vehicles, in order to reflect the purchasing power.

Let's talk about the effect on fossil fuel consumption: divide the map into North America, Europe, Eurasia, Middle East, Africa, Asia Pacific, treat North America as representatives, fossil fuel consumption during the period of 2001–2006 can be forecasted by the annual fossil fuel consumption during the period of 1980–2000. Compared with practical consumption during the period of 2001–2006, we can get whether the fossil fuel consumption has been reduced, Time series forecasting has been implemented.

All exponential smoothing methods are conveniently written as recurrence relations: the next value is calculated from the previous one. It is suitable for dealing with some stochastic quantity over time whose trend is stable. For single exponential smoothing, the formula is very simple:

$$\hat{y}_t = ky_{t-1} + (1-k)\hat{y}_{t-1} \qquad 0 \le k \le 1$$

y_{t-1} is the actual value for the moment of $(t-1)$, $\hat{y}_t$ is the predict value for the moment of t, the parameter k controls the amount of smoothing, however, there is still no good a unified method to choose coefficient k, we constrain the coefficient to the range $0 \le k \le 1$ by convention. If $k = 1$, the graph is not smoothed at all; if $k = 0$, the graph is absolutely smooth. A choice in the range $0 < k < 0.3$ allows the trend to change relatively slowly, a choice in the range $0.6 < k < 1$ allows the trend to rise or descend. We have already discussed the effects of different k values, compared with different k values and choose the suitable one. To set up these calculations, we need to specify the value for k and an initial value $\hat{y}_1$.

Make the mean of the values for years of 1980 and 1981 as the initial value to forecast the value for the year of 2003, so $\hat{y}_1 = 79.2778$.

160.3 Results

160.3.1 Choose the Coefficient

Forecast for fossil fuel consumption and made match forecast graph with various $k = 0.2$, 0.5 and finally 0.8, the value over observations 1980–2002. Thus, the forecast is available at period 2003. The forecast graph is more utopian when its trend approach reality graph, choose the match k as coefficient, via $\hat{y}_t = ky_{t-1} + (1-k)\hat{y}_{t-1}$, the predicted value is shown in Table 160.1.

The trend of forecast graph with $k = 0.8$, is the most approximate to reality graph, so the coefficient k is 0.8.

160.3.2 Double Exponential Smoothing-Based Prediction

Single exponential smoothing as described above works well for time series without an overall trend. However, in order to present an overall trend, double exponential smoothing comes in. Double exponential smoothing-based prediction makes one more exponential smoothing based on the data which were forecasted by single exponential smoothing, but the second exponential smoothing value for the period t is not the predicted value forecasted by single exponential smoothing for the period $(t + 1)$. Such equations were used to make fossil fuel consumption predictions:

Table 160.1 Fossil fuels reality and forecast consumption comparison

Years	Fossil fuels reality consumption	Forecast		
		k = 0.2	k = 0.5	k = 0.8
1980	80.11	79.27780	79.27780	79.27780
1981	77.92	79.31284	79.36540	79.41796
1982	74.17	79.27079	79.23400	79.16567
1983	72.97	79.36330	79.48366	79.61979
1984	76.80	79.21024	79.04084	78.80238
1985	76.69	78.51193	77.37976	76.33542
1986	76.50	77.57841	75.61205	74.34256
1987	79.38	77.19493	75.63652	75.39731
1988	82.94	77.03439	76.01437	76.19324
1989	84.75	76.92560	76.25241	76.43101
1990	84.14	77.20922	77.29805	77.96115
1991	83.77	78.03927	79.32875	80.67980
1992	85.69	79.16142	81.48940	83.05599
1993	87.16	80.14018	82.77232	83.85539
1994	89.03	80.88993	83.33060	83.88219
1995	90.02	81.71893	84.18278	84.80440
1996	92.81	82.66331	85.31180	86.11354
1997	94.37	83.76147	86.73297	87.74601
1998	95.18	84.89254	88.07489	89.08266
1999	96.61	86.24183	89.85693	91.12770
2000	99.12	87.68860	91.66632	93.00611
2001	97.19	89.07887	93.15312	94.31316
2002	98.33	90.45256	94.55023	95.62051
2003	99.32	91.96800	96.29000	97.54800

$$\begin{cases} S_t^{(1)} = ky_t + (1-k)S_{t-1}^{(1)} \\ S_t^{(2)} = kS_t^{(1)} + (1-k)S_{t-1}^{(2)} \\ \hat{y}_{t+T} = a_t + b_t T \end{cases}$$

where $S_t^{(1)}$ is single exponential smoothing value for the period t, $S_t^{(2)}$ is double exponential smoothing value for the period t, y_t is actual value for the period t, $\hat{y}_{t+T}$ is predicted value for the period $(t+T)$ and k is coefficient.

$$a_t = 2S_t^{(1)} - S_t^{(2)}$$

$$b_t = \frac{k}{1-k}\left(S_t^{(1)} - S_t^{(2)}\right)$$

The initial values $S_0^{(1)}$, $S_0^{(2)}$ can be got in the same way to $\hat{y}_1$. Based on the equations, the predicted value is shown in Table 160.2.

Here are forecast graph and active graph which can reflect the difference between predicted value and actual value clearly: (Fig. 160.1).

Table 160.2 Predicted value and relative factors

years	y_t	$S_t^{(1)}$	$S_t^{(2)}$	$\hat{y}_t$	$y_{t+1} - \hat{y}_{t+1}$	$(y_{t+1} - \hat{y}_{t+1})^2$
1980	80.110	80.110	80.110	80.11	0	0
1981	80.008	80.079	80.101	80.049	−0.041	0.001681
1982	79.496	79.904	80.042	79.708	−0.212	0.044944
1983	78.227	79.401	79.850	78.76	−0.533	0.284089
1984	76.246	78.455	79.431	77.06	−0.814	0.662596
1985	73.956	77.105	78.733	74.779	−0.823	0.677329
1986	71.867	75.534	77.773	72.334	−0.467	0.218089
1987	70.514	74.028	76.650	70.282	0.232	0.053824
1988	70.434	72.949	75.540	69.249	1.185	1.404225
1989	72.002	72.665	74.677	69.791	2.211	4.888521
1990	75.191	73.423	74.301	72.168	3.023	9.138529
1991	79.528	75.255	74.587	76.208	3.32	11.02240
1992	84.367	77.988	75.607	81.39	2.977	8.862529
1993	89.135	81.332	77.325	87.057	2.078	4.318084
1994	93.476	84.976	79.620	92.626	0.85	0.722500
1995	97.229	88.652	82.330	97.683	−0.454	0.206116
1996	100.43	92.185	85.286	102.04	−1.61	2.59210
1997	103.22	95.496	88.349	105.71	−2.49	6.20010
1998	105.73	98.566	91.414	108.78	−3.05	9.30250
1999	107.99	101.39	94.408	111.37	−3.38	11.4244
2000	110.06	103.99	97.284	113.58	−3.52	12.3904
2001	111.97	106.39	100.01	115.49	−3.52	12.3904
2002	113.73	108.59	102.59	117.17	−3.44	11.8336
2003	115.37	110.63	105.00	118.66	−3.29	10.8241
2004	116.99	112.54	107.26	120.07	−3.08	9.48640
2005	118.74	114.4	109.40	121.54	−2.8	7.84000
2006	120.79	116.32	111.48	123.23	−2.44	5.95360

During the period of 2001–2006, forecasting fossil energy consumption is obviously higher than actual fossil energy consumption, which indicates fossil energy has been saved. Therefore, for the economy, electric vehicles' widespread use is feasible and significant.

For the environment, CO_2 emission during the period of 2001–2006 can be forecasted by the data during the period of 1980–2000 in the same way to fossil energy consumption and compared with actual emissions: (Table 160.3).

Here are realistic CO_2 emissions graph and forecast CO_2 emissions graph: (Fig. 160.2).

Reality CO_2 emissions are much lower than forecast CO_2 emissions, which indicate the pollution has been improved because of electric vehicles' widespread use. In conclusion, for government, the widespread use of electric vehicles is beneficial to both the environment and the economic!

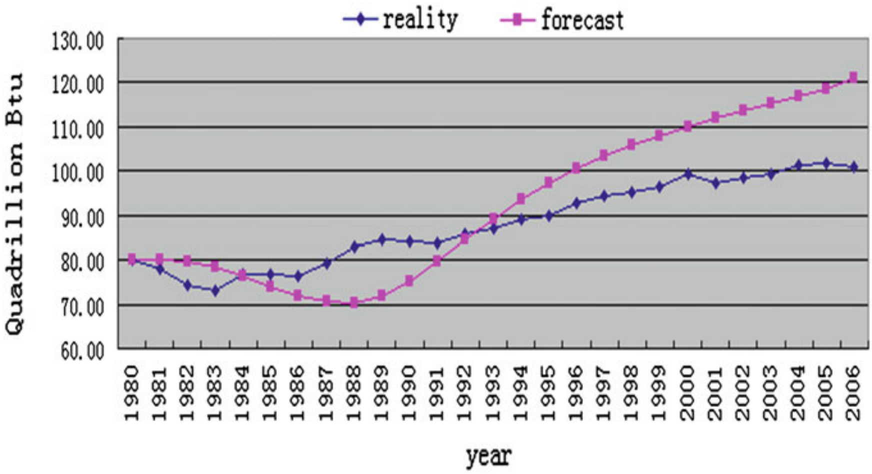

Fig. 160.1 Graphs of reality and forecast fossil fuels consumption

Table 160.3 Reality and forecast fossil fuels consumption

Years	Coal	Petroleum	Natural gas	Total/reality	Total/forecast
1980	1533.8	2706.1	1217.9	5457.8	5457.8
1981	1583.5	2565.9	1193.8	5343.2	5452.453
1982	1539.1	2431.9	1125.8	5096.8	5423.313
1983	1601.9	2366.8	1062.4	5031.1	5349.067
1984	1724.9	2463.9	1131.2	5320	5234.53
1985	1763.7	2448.7	1106.7	5319.1	5107.389
1986	1735.1	2530	1037.6	5302.7	4999.929
1987	1821.3	2577.9	1090.8	5490	4943.687
1988	1914.4	2682.1	1145.7	5742.2	4969.923
1989	1920.4	2714.9	1210.5	5845.8	5099.335
1990	1931.3	2632.4	1215.6	5779.3	5325.549
1991	1916.9	2573.8	1239.8	5730.5	5612.995
1992	1937.7	2621.8	1289.6	5849.1	5916.537
1993	1998.5	2637.4	1321.2	5957.1	6200.054
1994	2013.4	2700.3	1352.1	6065.8	6444.672
1995	2037.6	2667.3	1410.2	6115.1	6644.898
1996	2125.4	2755.1	1439.4	6319.9	6809.273
1997	2191.5	2799.3	1449.5	6440.3	6954.12
1998	2219.4	2859.1	1423.7	6502.2	7092.914
1999	2218.8	2917.9	1438.8	6575.5	7230.772
2000	2313.7	2978.6	1479.7	6772	7370.669
2001	2231	2991.3	1438.7	6661	7512.138
2002	2257.3	2982.1	1503.7	6743.1	7651.389
2003	2301.2	3042.5	1493.2	6836.9	7784.862
2004	2318.6	3148.3	1472.9	6939.8	7913.18
2005	2340.6	3183.9	1478.7	7003.2	8042.439

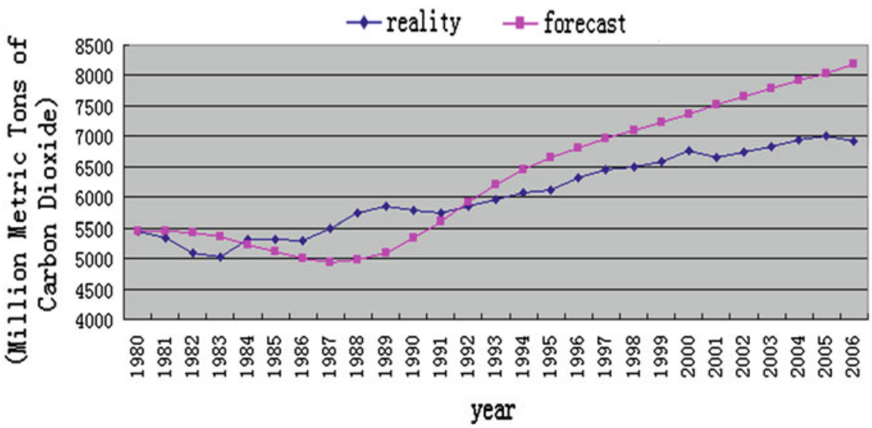

Fig. 160.2 Reality and forecast fossil fuels consumption

160.3.3 Fossil Fuels Consumption Conditions

We collect the global consumption of coal, oil and natural gas in the period of 1980–2000, then forecasted the trend of oil fuels consumption in the year of 2001–2006. Set North America region as an example, data are shown in Table 160.3:

With the help of least square method, we get:

$$\text{Forecast - consumption}\, f_{NAf} = -0.00003052 - 0.010487\,t + 0.56361\,t^2 - 5.916\,t^3 + 89.685\,t^4$$

$$\text{Reality - consumption}\, f_{NAr} = 0.00025515 - 0.018503\,t + 0.44548\,t^2 - 2.7877\,t^3 + 81.022\,t^4$$

On the basis of World Carbon Dioxide Emissions from the Consumption and Flaring of Fossil Fuels can get a figure of seven regions about Carbon Dioxide Emissions:

Table 160.4 Forecast and reality consumption of oil fuels from 2001 to 2006 in North America region

NO.	Years	Reality	Forecast
22	2001	97.19	111.9705
23	2002	98.33	113.7308
24	2003	99.32	115.3739
25	2004	101.32	116.9929
26	2005	101.78	118.7432
27	2006	100.84	120.7924

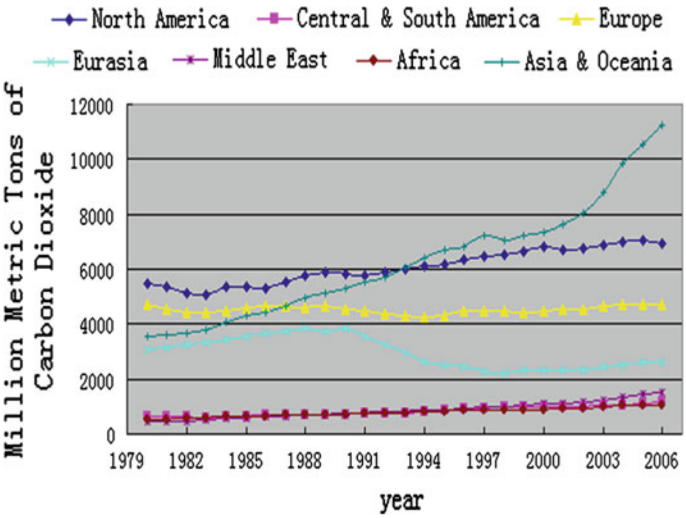

Fig. 160.3 World carbon dioxide emissions from the consumption and flaring of fossil fuels, 1980–2006

From Fig. 160.3, we can conclude that the Carbon Dioxide Emissions of North America, Europe and Eurasia in the period of 1998–2006 is tend to stability, Carbon Dioxide Emission of Asia and Oceania increases rapidly, the Carbon Dioxide Emissions of Central and South America, Middle East and Africa increases in a certain proportion. There must be a better one, with different energy distribution proportions for the different areas, when the energy distribution proportions of other areas trend to that of the area where Carbon Dioxide Emissions is stabile, we consider that energy utilization of other areas is optimized, not to aggravate environmental pollution (Figs. 160.4, 160.5 and 160.6).

With the amount of total energy increasing, Carbon Dioxide Emissions will increase with the amount of fossil fuels of total energy increasing, at the same time, Carbon Dioxide Emissions growth rate is used to represent for the degree of contamination. Comparative Analysis was implemented to compare the growth of Carbon Dioxide Emissions in seven regions. Use Carbon Dioxide Emissions growth rate, not the amount of Carbon Dioxide Emissions, as an index, for different energy base in different regions. The Figures above indicate Carbon Dioxide Emissions of North America is declining slowly, Carbon Dioxide Emissions of Europe has drastic change all the time, Carbon Dioxide Emissions of Asia and Oceania is increasing seriously. The degree of its Carbon Dioxide contamination is between North America and Asia and Oceania.

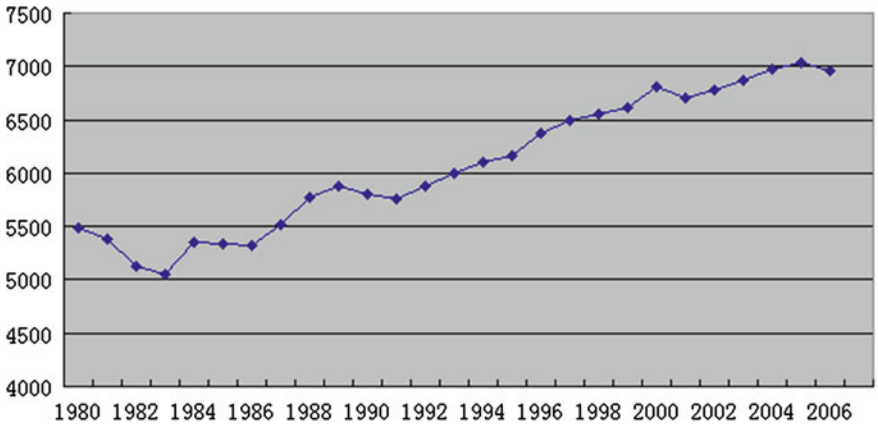

Fig. 160.4 North America carbon dioxide emissions from the consumption and flaring of fossil fuels

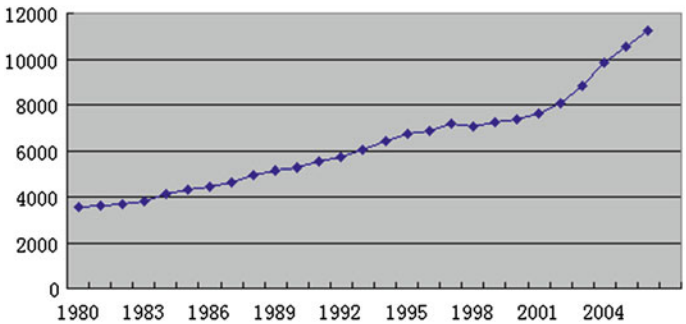

Fig. 160.5 Asia and Oceania carbon dioxide emissions from the consumption and flaring of fossil fuels

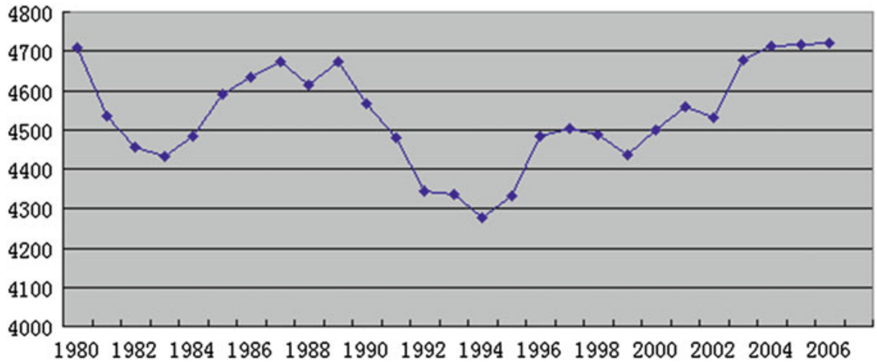

Fig. 160.6 Europe carbon dioxide emissions from the consumption and flaring of fossil fuels

160.4 Discussion

Cost effective, investor friendly economics of Electric vehicles have yet to be demonstrated. Conventional vehicles have had the great advantage of over a century of time to mature the current status of the market, where consumers expect a vehicle that is reliable, durable, with a long range, strong acceleration, and good power characteristics. Electric vehicles are still in the research and development phase, so they are not as advanced as fossil technologies.

The economic efficiency of electric vehicles depends substantially on the source of electricity. If the electricity comes from renewable sources, the electric vehicles are advantageous to the environment. If the electricity comes from fossil fuels, the electric vehicles can only be competitive with electricity generation onboard.

160.5 Conclusion

Our model indicates the government and vehicle manufacturers should support the development and use of electric vehicles. Electric vehicles' widespread use is useful on both the environment and the economic, as well as manufacturers' profit. With electric vehicles' widespread use, fossil fuel consumption and Carbon Dioxide Emissions decline.

Although with the use of electric vehicles, Carbon Dioxide Emissions can be improved, there is still unbalance energy distribution proportion, causing unnecessary energy waste and unnecessary pollution, thus, we offer the optimal energy distribution proportion to improve the environment and to save nonrenewable energy resource, which is consistent with the strategy of sustainable development.

Finally, I suggest the government make some policy and offer technological development to break the limit of insufficient power in battery to support the widespread use of electric vehicles.

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Chapter 161
Multi-Objective Production Planning Considering Partner Selection for Networked Manufacturing

Zhi-xiang Chen and Li Li

Abstract This paper studies an integrated optimization model of production planning with partner selection in a networked manufacturing system. An integrated multi-objective programming model is proposed and a numerical example is illustrated. The result shows the effectiveness and feasibility of the model. The model is suitable for the decision of production planning in networked manufacturing environment.

Keywords Production planning · Partner selection · Multi-objective programming · Networked manufacturing

161.1 Introduction

Production planning is a core decision problem in a manufacturing system. Traditional production planning is assumed that the production resource is limited within a manufacturer, or relative external resources are determined. With the globalization and wide application of information technology, more and more companies are outsourcing their non-core business to other collaborative partners. This new economic environment is leading up to the emergence of collaborative business (Niehaves and Plattfaut 2011). Networked manufacturing, or distributed manufacturing, is one kind of new collaborative business pattern in the era of IT, which not only changes the traditional business mode but also changes the business process. It links the business processes of different partners (e.g., Original Equipment Manufacturer (OEM), contact

Z. Chen (✉)
Department of Management Science, Sun Yat-sen University, Guangzhou, China
e-mail: mnsczx@mail.sysu.edu.cn

L. Li
International Business, Sun Yat-sen University, Zhuhai, China
e-mail: Li_whileblue@163.com

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manufacturers (CM) and other partners) together and forms a strategic alliance to respond to the customer demand. Under this new business environment, the production planning decision mechanism is different from the traditional production planning. Therefore, it is important to discuss the decision methods of production planning for networked manufacturing system (Gnoni et al. 2003).

There are some authors have researched the problem of production planning for distributed and networked manufacturing. Gnoni et al. (2003) deal with lot sizing and scheduling problem of a multiple-site manufacturing system with capacity constraints. Similarly, Leung et al. (2003) study the multi-site aggregate production planning with multi-objective using goal programming approach. Jolayemi and Oloruniwo (2004) develop a deterministic model for planning production and transportation quantities in multi-plant and multi-warehouse environment with extensible capacities. Ling et al. (2006) study the distributed production planning with supplier selection using Analytical Target Cascading method. Dudek and Stadtler (2005) study a negotiation-based production planning between supply chains partners. Boulaksil and Fransoo (2009) study one OEM manufacturing firm which outsources some of its production activities to a contract manufacturer. Lin et al. (2009) study an interactive meta-goal programming based decision method of collaborative manufacturing. In the study, decision participate can interactively make decision with other partners during the decision, and each partner can consider his (her) own individual local objective and preference, finally, a global optimization result is reached. Chung et al. (2010) apply genetic algorithm (GA) to study the multi-factory production planning problem. In the model, different factories with capacity constraints and precedence relationships are involved, and order completion time, i.e., makespan is taken as objective of the model. Jung (2011) studies a fuzzy AHP-GP approach for integrated production planning considering manufacturing partners. In the model, decision is made to allocate production tasks to partners.

In this paper, we study a multi-objective programming method for networked manufacturing considering partner selection. The model can concurrently decide the production lot size and partner selection. This method is especially suitable for the OEM driven networked manufacturing system, in which, collaborative partners are selected when make production planning and allocate production tasks to different partners.

161.2 Formulation of the Problem

161.2.1 Assumptions and Notations

Assumptions

Our model will be formulated based on the production networked shown in Fig. 161.1. In order to formulate the problem, the following assumptions will be needed.

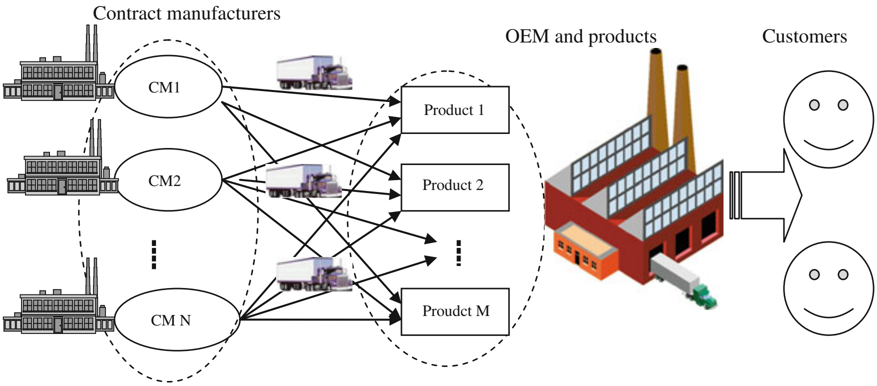

Fig. 161.1 Production network of OEM driven manufacturing

1. OEM company acts as the decision maker of the production planning;
2. Demand of products in periods is known;
3. Production planning decision concurrently considers the supplier or contract manufacturer selection;
4. All demand in each period should be satisfied and no shortage and backlog is allowed;
5. Transaction cost is supplier dependent but is not dependent on variety and quantity of the products;
6. Holding cost of products is product dependent.

The system of the integrated inventory model is shown as Fig. 161.1.

Notations

The following notations will be used in the model.

Indices:

i (=1, …, M) Index of products
j (=1, …, N) Index of contract manufacturers
t (=1, …, T) Index of time periods.

Parameters:

$D_{i,t}$ Demand of product i in period t (units/period)
$C_{i,j}$ Per unit price of product *i* supplied by contract manufacturer j ($/unit)
H_i Holding cost of product i per period and per unit ($/unit/period)
O_j Transaction cost for contract manufacturer i ($/per time)
w_i Storage space of product i (m^3/per unit)
W Total storage space (m^3)
B_t Budget in period t
$q_{i,j}$ Quality level of product i offered by contract manufacturer j
S_j Service level of contract manufacturer j
$P_{i,t}$ Sell price of product i in period t

f_i Per unit transportation cost of contract manufacturer j.

Decision variables:

X_{ijt} The quantity of product i purchased from contract manufacturer j in period t

$Y_{jt} = 1$ If contract manufacturer j is selected in period, 0, otherwise.

Intermediate variable:

I_{it} Inventory level of product i in period t.

161.2.2 Model Formulation of the Problem

In this paper, the problem can be described as: there is a networked manufacturing system consisting of one OEM and multiple contract manufacturers (CMs), in which OEM is responsible for the product sale, market development and customer service, while CMs are responsible for the production of products. In order to meet customer demand, OEM needs concurrently decide which product will be assigned to which CM to produce, to maximize the total profit, total product quality level and customer service level. The three objective functions are expressed as follows,

Objective functions

$$\max TP = \sum_{i=t}^{M}\sum_{t=1}^{T} P_{it}\sum_{j=1}^{N} X_{ijt}\left\{\sum_{i=1}^{M}\sum_{j=1}^{N}\sum_{t=1}^{T} C_{ij}X_{ijt}\right\} + \sum_{j=1}^{N}\sum_{t=1}^{T} O_j Y_{jt} + \sum_{i=1}^{M}\sum_{t=1}^{T} H_i\Big(\sum_{k=1}^{t}\sum_{j=1}^{N} X_{ijk} - \sum_{k=1}^{t} D_{ik}\Big) + \sum_{i=1}^{M}\sum_{j=1}^{N}\sum_{t=1}^{T} f_j X_{ijt} \tag{161.1}$$

$$\max TQ = \frac{\sum_{i=1}^{M}\sum_{j=1}^{N} q_{ij}\sum_{t=1}^{T} X_{ijt}}{\sum_{i=1}^{M}\sum_{j=1}^{N}\sum_{t=1}^{T} X_{ijt}} \tag{161.2}$$

$$\max TS = \frac{1}{T}\sum_{t=1}^{T}\frac{\sum_{j=1}^{N} S_j Y_{jt}}{\sum_{j=1}^{N} Y_{jt}} \tag{161.3}$$

The first objective is to maximize the total profit; the second objective is to maximize the total quality level of all products and the last objective is to maximize the total service level.

Constraints

$$I_{it} = \sum_{k=1}^{t}\sum_{j=1}^{N} X_{ijk} - \sum_{k=1}^{t} D_{ik} \geq 0 \quad \text{for all i and t.} \tag{161.4}$$

$$\left(\sum_{k=t}^{T} D_{ik}\right) Y_{jt} - X_{ijt} \geq 0 \quad \text{for all i, j, and t.} \tag{161.5}$$

$$\sum_{i=1}^{M} w_i \left(\sum_{k=1}^{t}\sum_{j=1}^{N} X_{ijk}\right) - \sum_{k=1}^{t} D_{ik} \leq W \quad \text{for all t.} \tag{161.6}$$

$$\sum_{i=1}^{M}\sum_{j=1}^{N} X_{ijt} C_{ij} \leq B_t \quad \text{for all t.} \tag{161.7}$$

$$\sum_{i=1}^{M}\sum_{j=1}^{N}\sum_{t=1}^{T} X_{ijt} = \sum_{i=1}^{M}\sum_{t=1}^{T} D_{it} \tag{161.8}$$

$$Y_{jt} = \{0,\ 1\} \quad \text{for all j and t.} \tag{161.9}$$

$$X_{ijt} \geq 0 \quad \text{for all i, j, and t.} \tag{161.10}$$

Constraint of (161.4) describes that all requirements must be filled in the period in which they occur and shortage or backlog is not allowed. Constraint (161.5) describes that there is not an order without charging an appropriate transaction cost. Constraint (161.6) means that storage space is limited and constraint (161.7) means that total purchasing cost is not exceed the budget. Constraint (161.8) restricts the total supply equal to the total demand. The last two constraints (161.9) and (161.10) are variable constraints respectively for supplier selection and purchasing quantity.

161.3 Solution Procedure

Because the model is a multi-objective programming problem, so, in order to solve it, it is necessary to convert the multi-objective programming model into single-objective programming model.

There are different methods for converting multi-objective programming model into single-objective programming model. In this paper, we use the following method.

$$\max = \varpi_P \frac{TP}{TP_{\max}} + \varpi_Q \frac{TQ}{TQ_{\max}} + \varpi_S \frac{TS}{TS_{\max}} \tag{161.11}$$

s.t. constraints (161.4–161.10).

In above model, ϖ_P, ϖ_Q, ϖ_S are the weights of the objectives of total profit, total quality and total service respectively. The $TP_{\max}$, $TQ_{\max}$ and $TS_{\max}$ are the optimal values of total profit (TP), total quality (TQ) and total service (TS) under their own individual single objective model without considering other objectives respectively.

There are different methods can be used for weight assignment, such as Analytical Hieratical Process (AHP). For the sake of convenience and saving pages, in this paper, we first automatically give out the weights of objectives. The weights are 0.30, 0.40, and 0.30 for total profit, quality and service respectively.

The solution procedure is described as:

Step 1. Initialization and data setting for the model.
Step 2. Solve the three single-objective programming models of total profit, total quality and total service respectively to obtain $TP_{\max}, TQ_{\max}, TS_{max}$.
Step 3. Solve weighted multi-objective programming model (161.11) to obtain solution.

161.4 Numerical Example

In this section we use an example to show the effectiveness of the model. Data are listed out in Table 161.1

Use the data, we first solve each objective independently using Lingo11, and obtain the maximum objective value as.

$$TP_{\max} = 35433.07,\ TQ_{\max} = 0.9718051$$
$$TS_{\max} = 0.964$$

Then we solve model (11), obtain the objective value

TP = 35334.83, TQ = 0.9658604, TS = 0.9580000

The production plan and contract manufacturer selection result is shown in Table 161.2.

From the result we can see that, when use multiple-objective model, the optimal value of each objective in the integrated mode will be less than the objective value in single-objective model. This reveals the trade-off relationship, i.e., when consider multiple objectives in the decision model, each objective can only be suboptimal When there are more objectives, this relationship will be more significant.

Table 161.1 Parameters of model

Product	Demand/price of OEM					Price/quality level of CM						Holding cost	Storage space
	Period 1	Period 2	Period 3	Period 4	Period 5	CM1		CM2		CM3			
						C	q	C	q	C	q		
A	12/100	15/120	17/130	20/120	13/110	30	0.97	33	0.95	32	0.95	1	10
B	20/200	21/240	22/210	23/240	24/210	32	0.95	35	0.97	30	0.97	2	40
C	20/150	19/170	18/140	17/160	16/155	45	0.98	43	0.96	45	0.95	3	50
Transaction cost ($)						110		80		102			
Service level						0.95		0.90		0.97			
Transportation cost ($/unit)						6		5		7			

Note CM = contract manufacturer, total storage space S = 200. C = supply price of CM, q = quality level of CM

Table 161.2 Solution result t

	t = 1			t = 2			t = 3			t = 3			t = 4			t = 5		
	Xijt	Yjt	Iit	Xijt	Yjt	Iit	Xijt	Yjt	Iit	Xijt	Yjt	Iit	Xijt	Yjt	Iit	Xijt	Yjt	Iit
A(i = 1)												**20**			**13**			
CM1(j = 1)	12	**1**		**15**	**1**		**37**	**1**		0	0		0	0		0	0	
CM2(j = 2)	0			0			0			0			0			0		
CM3(j = 3)	0			0			0			0			13			0		
B(i = 2)						**2.2**									1.8			
CM1(j = 1)	0			0			19.8			0			0			0		
CM2(j = 2)	0			0			0			0			0			0		
CM3(j = 3)	20	1		23.2	1		0			0			24.8			22.3		
C(i = 3)																		
CM1(j = 1)	0			19			0			18			0			0		
CM2(j = 2)	20	1		0			0			0			0			0		
CM3(j = 3)	0			0			0			0			**17**	1		**16**	1	

161.5 Conclusions

The increasing global competition is changing the business mode. More and more companies are seeking cooperation with other companies and forming a strategic alliance to compete with competitors. Under this business background, production planning decision is different from that of traditional manufacturing system. This paper studies an integrated optimization model of production planning with partner selection in a networked manufacturing system. An integrated multi-objective programming model is proposed and a numerical example is illustrated. The result shows the effectiveness and feasibility of the model. The model is suitable for the decision of production planning in networked manufacturing environment.

Further research can be made to extend the work based on this paper. First, it can be considered multiple transportation alternatives in the model. Second, it also can be considered the demand characteristics of customers, e.g., different customer orders have different preference for selecting partner. These strategies will extend the model into a more practical one.

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Chapter 162
Employee Assistance Program: A New Means of China Enterprise Management of Innovation

She-hong Liang, Lin Wang, Kan Shi and Peng Gao

Abstract This paper describes the development of Employee Assistance Program (EAP) at home and abroad in near one hundred years. By analyzing the differences of EAP in background of introduction and environment of implementing at home and abroad, this paper put forward new features of EAP in China. It is also pointed out three new functions of EAP in the modern enterprise management. Firstly, EAP has become a new means of spreading corporate culture deeply. Secondly, EAP has become a new ways of innovative human resources management. Thirdly, EAP has been a new breakthrough for the innovation of enterprises party-building and trade union work. In short, EAP would be inevitable trend of development as innovative tools of China enterprise management.

Keywords Employee assistance program · New features · New functions · Management of innovation

162.1 Introduction

Employee Assistance Program (EAP) that is set up for employees by organization is systematic and long-term welfare and support programs. It demands professional staff to provide diagnosis, evaluation, training, professional guidance and advices for employees to help themselves and their family members solve their psychological and behavioral problems, which aim to improve employee's work performance and health in the organization, and improve organizational climate and business management performance (Wang 2005). EAP is originated in the United States. It has been widely used in many well-known enterprises and institutions in

S. Liang (✉) · L. Wang · K. Shi · P. Gao
School of Management, Graduate University of Chinese Academy of Sciences, Beijing, China
e-mail: LLLSH@126.com

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developed countries now. Just as introduction of EAP in China soon, so its background of introduction and environment of implementing is different from abroad. EAP in China shows new features and new functions thus it has become a new means of China enterprise management of innovation.

162.2 Development History of EAP

162.2.1 The Development of EAP Abroad

EAP was originated in the 1920s when business owners found that employees who were addicted to alcohol would negatively affect to the business in the U.S (Dickman 1985). But simple dismissal didn't solve the problem, then they spent money to hire outside experts to help employee give up excessive drinking, which is the origin of EAP—Occupational Alcohol Programs (OAP). To the 1940s and 1950s, OAP developed Alcoholism Prevention Programs (APP) by the U.S. Congress and other companies, associations, labor management committee and government agencies. On the prevention of alcoholism, they made some new and occupational alcohol prevention and management method (Anderson and Larimer 2002). To the 1960s and 1970s, managers had found that alcohol prevention programs alone couldn't completely solve the problem of low performance of employees. Because many reasons impact work performance of employees, then the focus of EAP was natural from identifying whether employees were addicted to alcohol to explore systematically the reasons for low performance of employees (Courtois et al. 2004). Since the 1970s, dramatic changes had taken place in American society. Family violence, divorce, depression and other problems had been increasing influence on behavior of employees. Then the service of OAP was gradually extended, its service include work pressure, mental health, crisis of reducing the staff, disaster, career development, healthy lifestyle, legal disputes, financial problems, weight loss and eating disorders, and extend the service to the families of employees, including spouses and children of employees (Teich and Buck 2003). That was the prototype of EAP (White et al. 1996). Since the 1980s, EAP had entered into fully integrated and systematic phase (Emener 2009). Some firms have started to introduce EAP into a systematic and long-term welfare and support programs. Therefore, EAP has developed into a comprehensive service, its practitioners include not only psychological counselor and treatment expert, but also manager at all levels in the enterprise and trade unions, health care institutions, social organizations (Hopko and Hopko 2003). According to statistics, nearly a quarter of U.S. corporate employees enjoy the service of EAP. In the U.S. "Fortune" magazine's Fortune 500 companies, 90 % of them have established service system of EAP, 80 % of them have employed professional company for providing the service of EAP. This service has been widely used in government, community and other public services.

162.2.2 The Development of EAP in China

The development of EAP in Hong Kong and Taiwan was ahead of Chinese mainland. In the early 1990s, some non-profit organizations in Hong Kong started to provide service of social work (Maiden and Hardcastle 1986). EAP in Taiwan began in 1972 which founded the "Big Sister Organization" (BS) in Taiwan Matsushita Electric companies. BS was set up to help new employees adapt to the environment, as well as a bridge of communication between first-line workers and their supervisor. The service of EAP in Taiwan can be divided into five categories, which is psychological counseling, education and development training, recreation and sports, health-care and welfare services (Liu 2006).

Chinese mainland firstly introduced EAP in the large-scale and foreign-funded enterprises. Then the service of EAP abroad began to enter Chinese market. Some local institute of EAP services have appeared because the vast majority of employees who accept EAP services in China are local employees. Some large state-owned enterprises have begun to use EAP services. In March 2001, Xi-chao Zhang who is domestic scholar carried out complete EAP counseling services in the customer service department of Lenovo Group. Researchers spread knowledge of mental health promotion to employees and enhance their awareness and understanding of psychological problem by cards, posters and other forms of web. They also provide managers with a wide variety of training, which make managers aware of the roles of psychological counseling in business management and feel the benefits of EAP to the enterprise (Zhang 2006). At present, EAP involve personal life, work issues and organizational development. Personal life is related to alcohol and drugs, emotional control, health problems, interpersonal skills, family relations, economic issues, emotional issues, legal issues. Work issues related to job requirements, work balance, work stress, work environment, sense of work fairness, workplace sexual harassment, work and other aspects of interpersonal conflict. Organization issues are involved with some projects of business strategic development such as employees adapting to layoffs in the organizational change process, accumulating psychological capital to build and strengthen competitive advantage, etc. (EAPA 2003).

In addition, that large-scale forum of EAP held in the 21st century and the publication of EAP monographs have played an indispensable role for the development of EAP in China. EAP have been formally included in the national Employee Assistance division "1 + N" compound training program by China's vocational and technical training center of Ministry of Human Resources and Social Security of China in December 2010. "Employee Assistance Division Curriculum Development Center" has been formally established in Beijing, which is charged for EAP teaching materials and training teacher. This will be a new breakthrough for EAP talent training, which will lay the talent base for promoting the development of EAP in more broader and deeper level.

162.3 New Features of EAP in China

162.3.1 The Differences of EAP in Background of Introduction and Environment of Implementing at Home and Abroad

We founded that environment of implementing EAP in China and abroad are completely different by reviewing the development process of EAP. The differences mainly embody in the following aspects. First, the background of introducing EAP is different. EAP was developed by helping alcohol-addicted employees to give up excessive drinking abroad, while EAP was developed by investigating and diagnosing employee mental health in China. Second, the means of implementing EAP is different. EAP is mainly for individual counseling and therapy abroad, while EAP is based on group psychological survey and training, then employees have some demands for the individual psychological counseling and treatment in China. Third, people of EAP service are different. Foreigners generally accepted psychological counseling, but Chinese people are still excluded to psychological counseling. Fourth, the social environment of implementing EAP is different. Developed countries are relatively short of labor, so physical and mental health of workers are more been concerned. Chinese Government is more concerned about harmonious labor, employee well-being and social stability because of the relatively surplus of labor in China. Finally, from the government support point of view, foreign government and legal institutions more support for EAP while Chinese Government and legal institutions involved less in the EAP.

162.3.2 New Features of EAP in Chinese Enterprises

Because the background of introduction and environment of implementing EAP at home and abroad are very different, EAP show the following new features in China.

1. From the purpose of implementing EAP, it is more concerned of caring employee culture and creating positive organizational climate in China.

At present, decision-maker of Chinese enterprise hope to reflect more employee-caring culture, create positive organizational climate and establish harmonious labor relationship by EAP. Then it will be precautionary. EAP not only enhance the cohesion of enterprises and employees' sense of belonging, but also stimulate the intrinsic motivation of employees and further improve their work performance.

2. From the content of implementing EAP, it is more focused on spreading widely the knowledge of mental health and enhancing employee self-management skills in China.

The content of EAP is more concerned about the popularization of knowledge of mental health, focusing on developing positive psychological forces of employees, enhancing psychological capital of employees and improving self-management skill of employees. It is the relative weakening of psychological counseling and treatment for individuals. This is more in line with Chinese conditions. Through spreading universal psychological knowledge, it will enhance skill of employee which will help them handle family-related issues and reduce the psychological distress and emotional disorder of employee which could result in their low performance.

3. From the means of implementing EAP, it mainly focused on group training, supplemented with individual counseling in China.

EAP is implemented by organization and mainly focused on group training, supplemented by individual counseling in current China. This feature came from the means of introducing EAP in China and the unique ideas of Chinese people. Because counseling industry which started to develop in China has not been widely recognized. Together with Chinese people less talkative, their mental ideas of "shame of family should not be expressed to others", individual counseling abroad is difficult to apply to the present stage of China. So this will make the means of implementing EAP in China become more diverse, more Chinese characteristics.

4. From the main body of implementing EAP, the executive department of EAP is diverse, which is more Chinese characteristics.

The implementation of EAP need supports of manager especially decision-maker in the organization. The implementation department of EAP in China is also more diversified because the nature of Chinese enterprises is different. Some are party-building sector, some are trade unions sector, some are human resources sector, and others are executive branch of government. Especially the party-building sector introducing EAP in large state-owned enterprises which is more Chinese characteristics, China's large state-owned enterprises should learn from them. We should also learn more from EAP abroad which implemented by human resources sector, health department in conjunction with insurance companies, medical institutions, etc. We hope that EAP become into a long-term benefits rather than short-term incentive optional in order to protect the long-term development of EAP in China.

5. From the results of implementing EAP, it is more concerned social value evaluation and make light of economic assessment in China.

Since short-term results of EAP is difficult to assess, the enterprises which performed EAP in China are more good economic organizations so they are more concerned about the long-term social value and make light of short-term economic benefits. This is contrary to foreign enterprises which pay more attention to precise assessment of return on investment (ROI). It also shows that Chinese companies began to shift their attention from concerning material welfare of employees to spiritual welfare of employees. They began to think mostly EAP as a human investment, rather than administrative costs.

162.4 New Functions of EAP in China Enterprise Management

162.4.1 EAP has Become a New Means of Spreading Corporate Culture Deeply

From the main purpose of implementing EAP in China, EAP have become a new measure of Chinese enterprises which want to build People-oriented management philosophy. It has also become a new means of Chinese enterprises implementing employee-caring culture. By the systematic implementation of EAP, enterprises will establish organizational culture which is respected for employees, concerning about difficulty of employees, stimulating positive force of employees, training employees to solve problems and pay attention to their personal development (Council on Accreditation 2003). So the enterprises will form a stable, healthy and harmonious labor relationship and help company better respond to business restructuring, mergers and acquisitions, layoffs and other changes and crisis, which is same with the aim of building modern corporate culture. Therefore, EAP has become a new means of Chinese enterprises spreading organizational culture deeply.

162.4.2 EAP has Become a New Ways of Innovative Human Resources Management

EAP help employees solve all the difficulties and promote their health and development as a systematic welfare (Druss et al. 2001). This will improve employee's satisfaction and enhance organizational cohesion so that they have more sense of identity and belonging, which are more conducive to attract and retain talent. This is similar with the function of human resource management. Meanwhile, EAP can not only help employee alleviate their work pressure, improve their morale, enhance their motivation, learn effective interpersonal skills, but also make the staff quickly adapt to new environment, overcome their bad habits, face with their career crises, improve their job skills, which will save indirectly the cost of recruitment and training, reduce error of dismissal, alleviate the labor-management conflicts and reduce the cost of human resource management (Smith et al. 1982). Therefore, EAP has become a new ways of corporate human resource management of innovation.

162.4.3 EAP has Been a New Breakthrough for the Innovation of Enterprises Party-Building and Trade Union Work

In 2007, Jin-tao Hu who is Chinese President proposed that we should strengthen and improve ideological and political work, paying attention to care people and psychological counseling, with the correct approach to handling interpersonal relationship in the report of the 17th Party Congress. This thesis greatly contributed to the development of psychology and EAP in China. In particular, some domestic large enterprises have been gradually implemented EAP and the results are significant. For example, China Mobile Group Co., Ltd. introduced EAP into the China Mobile's ideological and political work by their party-building sector, which will make the traditional "ideological education" become the culture of "psychological care", make the "thinking change" become the "inner communication", from the employee's passive acceptance to active consultant. The EAP help employee reduce their psychological puzzle and work stress so it has become an innovative method of ideological and political work and broaden the field of ideological and political work. Therefore the successful implementation of EAP in China Mobile Group is useful attempt and important innovation for the work of party-building in state-owned enterprises.

After the incident of "continuous leaping to the death" in FOXCONN in 2010, the National Federation of Trade Unions issued the Advices on Further Improving the workforce and social stability work, which specially emphasize to strengthen psychological counseling of the young workers, especially migrant workers. This further indicates that psychological assistance work for employees will play important roles on the development of enterprises. Furthermore, large state-owned mining companies introduced EAP by the enterprise union in order to enhance assistance skill of first-line managers in December 2010, which received wide acclaim. This is not only an important measure for business to build employee-caring system, but also a breakthrough and an innovation for company trade union work.

162.5 Conclusion

In summary, the development of EAP have shown new features in recent years in China and carry out new functions in enterprise management. From the purpose, contents and methods of implementing EAP, it exclude effectively the interference factors which impact on work performance of employee, maintaining their mental health and stimulate their inner potential of work, which is same with the ultimate target of corporate culture and human resource management. Therefore EAP has become not only a new ways of business management in the workplace to provide humane care for employee, but also a new means of China business management innovation.

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Chapter 163
The Development Countermeasures Research of China's High-End Equipment Manufacturing Industry

Gui-bin Men, Yan Li and Yi-xiu Liu

Abstract High-end equipment manufacturing industry is one of the seven areas of the strategic new industry, according to The National Twelve-Five plan. The development of high-end equipment manufacturing industry not only affects the growth of China's economy, but also affects the strengthening of comprehensive national strength. This paper briefly analyzes the current situation about the development of the high-end equipment manufacturing industry and the existing problems, then puts forward some related countermeasures and suggestions to the development of China's high-end equipment manufacturing industry.

Keywords Advanced technology · Development countermeasures · High-end equipment manufacturing industry · Innovation

163.1 The Contents and Features of the High-End Equipment Manufacturing Industry

The equipment manufacturing industry mainly refers to the floorboard of the manufacturing industry, which provides technical equipments for national economy and national security, including seven categories, such as metal products, general equipment, special equipment, transportation equipment, electrical

G. Men (✉) · Y. Li · Y. Liu
Management Department, Dalian Jiaotong University, Dalian, China
e-mail: mengguibin@126.com

Y. Li
e-mail: 1225liyan@163.com

Y. Liu
e-mail: mylyxheze@163.com

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equipment, electronics and communication equipment, instruments and cultural office (Liuqin 2011).

High-end equipment manufacturing industry is a high-end field of the equipment manufacturing industry. It is a high-end strategic new industry, which is guided by the high technology, and located in the high end of the value chain and in the core link of the industry chain. It is the foundation and key to promote the transformation and upgrading of China's industrialization. It is a strategic selection to seize the commanding height of the future economy in science and technology, strongly promoting a steady and rapid development for China's economy.

High-end equipment manufacturing industry has some characteristics, including dense technology, high added value,and located in the core industrial chain, etc. (Cai et al. 2010). The development goal of high-end equipment manufacturing industry is that, through industrial structure adjustment, China can eventually master the core technology for high-end products, and make China have the ability to product high-end products, and export products with high added value.

China's economy is in a critical period of development transformation, the development of high-end equipment manufacturing industry has become an irreversible trend. In recent years, the development of high-end equipment manufacturing industry is not only supported by the national related policy, but also influenced by two factors, including urbanization accelerating and domestic market expanding. In such a major premise, the development of China's high-end equipment manufacturing industry can realize great-leap-forward development from made in China to be created in China.

163.2 The Development of Equipment Manufacturing Industry in Present Situation

On the whole, China's equipment manufacturing industry has a large industry scale, complete range, and perfect system, but the technology is at a low level (Zhang 2005). Actually, China is a big country with equipment manufacturing industry, but not a powerful country. From a quantitative point of view, China has formed a number of special equipment manufacturing bases, such as the communication equipment and computer manufacturing base of the pearl river delta, the automobiles and auto parts manufacturing base of the pearl river delta around Shanghai, the Major equipment manufacturing base in Northeast, and the national defense equipment manufacturing base in southwest and northwest (Li and Qu 2008). The number of enterprises and gross industrial output value of China's equipment manufacturing industry for recent 5 years are shown in Tables 163.1 and 163.2.

From Tables 163.1 and 163.2, we can draw that the total number of China's equipment manufacturing enterprises from 2006 to 2010 are respectively: 93,377, 107,333, 144,653, 147,176 and 154,406. The gross industrial output value

Table 163.1 The development quantities of China's equipment manufacturing industry in recent 5 years (unit: piece)

Industry	Year				
	2006	2007	2008	2009	2010
Metal products	115573	118008	224547	224771	225703
General equipment	222905	226757	336919	337374	339699
Special equipment	111615	113409	118685	119147	220083
Transportation equipment	112586	114091	118808	119441	220718
Electrical equipment	116905	119322	225727	226443	227537
Electronics and communications equipment	99709	111220	114347	114284	114838
Instruments and cultural office	44084	44526	55620	55716	55828

Data sources China Statistical Yearbook finishing (2007–2011)

Table 163.2 Gross industrial output value of China's equipment manufacturing industry for recent 5 years (unit: billion yuan)

Industry	Year				
	2006	2007	2008	'2009	2010
metal products	8852.947	11144.708	11502.961	11608.295	22013.461
General equipment	11373.476	11841.552	22468.756	22736.152	33513.274
Special equipment	7795.331	11059.198	11452.13	11678.44	22156.183
Transportation equipment	22038.292	22714.74	33339.528	44173.032	55545.263
Electrical equipment	11816.552	22401.907	33042.884	33375.799	44334.441
Electronics and communications equipment	33307.758	33922.377	44390.282	44456.263	55497.067
Instruments and cultural office	3353.927	4430.799	4498.449	5508.331	6639.907

Data sources China Statistical Yearbook finishing (2007–2011)

of equipment manufacturing industry in China from 2006 to 2010 are respectively: 10,538.28 billion yuan, 12,370.57 billion yuan, 15,192.03 billion yuan, 16,928.02 billion yuan, and 21,686.14 billion yuan. The growth trend diagram is shown in Figs. 163.1 and 163.2.

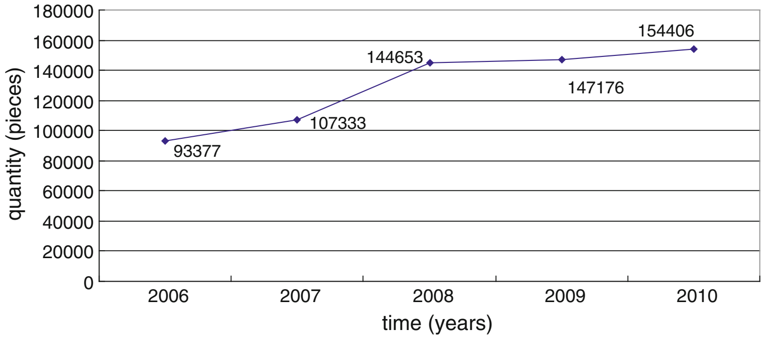

Fig. 163.1 The growth curve of equipment manufacturing industry in China

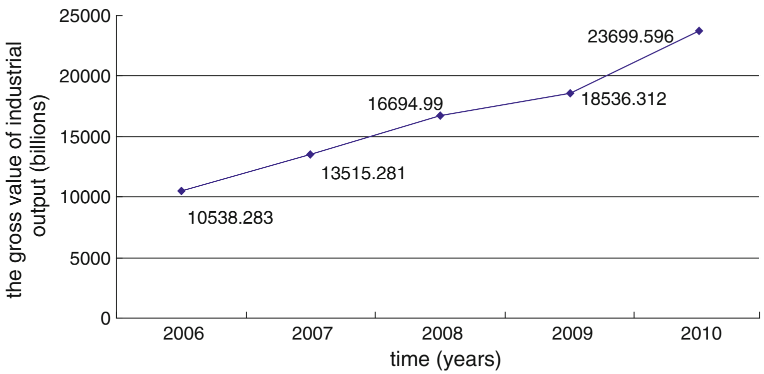

Fig. 163.2 The output growth curve of equipment manufacturing industry in China

From Figs. 163.1 and 163.2, we can see that no matter from quantity or gross industrial output value, China's equipment manufacturing industry is increasing year by year, which is related to the development of China's economy and the attention of the government.

163.3 The Present Problems of China's High-End Equipment Manufacturing Industry

163.3.1 Over-Reliance on Investment Growth

Over the past few years, China's equipment manufacturing industry mainly relied on the extensive development mode, because local governments excessively pursuited the growth of local economy, meanwhile, all the enterprises blindly invested and blindly pursued the scale of enterprises and the expansion of output. Besides, competition among enterprises was anabatic and market economy was in chaos, which restricted the development of high-end products. The massive investment of enterprises, also caused convergence of the local industrial structure, resulted in environmental pollution, and exacerbated the waste of resources.

163.3.2 Lack of Core Technology, Higher External Dependence

China is a large developing country with more than 1.3 billion people. The situation that high-end equipment manufacturing industry in China is big but not strong has been restricting the rapid development of China's economy. The development of equipment manufacturing industry not only embodies the level of China's comprehensive national strength, but also affects China's international status. Along with the reform and opening-up, China's high-end equipment manufacturing industry makes some achievements, but some of the crucial techniques are still firmly mastered in western countries, so a lot of core parts in manufacturing field completely depend on imports (Shen 2011). Raw materials and low human capital make China gradually become a worldwide processing factory, and cause a big gap with world power. The figures given by Wang Ruixiang, the president of China's machinery industry federation, show that 80 % of China's integrated circuit chip manufacturing equipment, 40 % of the large petrochemical equipment, 70 % of the automobile manufacture key equipment and advanced intensive agricultural equipment still rely on imports.

The independent R&D ability of China is weak, innovation ability is poor, even though, the introduction is always heavy, but the innovation is light, which make China have a large gap with foreign countries (Zhang et al. 2011). A lot of enterprises are lack of funds to invest in R&D, the management mechanism of research departments is not perfect, the number of innovation achievements is small, and the quality is low. The shortages of high quality professional and technical personnel and management personnel, exceed supply of common talents demands, and exceed demands of advanced talents supply, also have a great effect on the innovation ability of the enterprises.

163.3.3 High Energy Consumption of Products, Low Resource Utilization

China's traditional development model is energy consumption, which wastes a lot of resources, at the same time, there are a lot of defects in the development process. High energy consumption and low output make China's high-end equipment manufacturing industry lack international competitiveness. After all, the earth 's natural resources are limited, high pollution and high emission also sound a warning to us, which is not conducive to the continuous and stable development for China's economy.

163.3.4 Large Enterprise Groups are Not Strong

There is a large number and wide distribution of China's high-end equipment manufacturing industry, but the situation that industries are big but not strong, has become bottleneck for the development of China's high-end equipment manufacturing industry (Xu 2011). On the aspect of R&D capabilities and independent intellectual property rights, China's enterprises still have a large gap with the developed countries. The amount of China's large enterprises is however large, but they are lack of systematic management of industrial chain (Jing and Li 2011). Therefore, in order to solve the competition between enterprises, we must improve chain structure of the equipment manufacturing industry, and enhance the innovation ability of enterprises.

163.3.5 Financing System is not Perfect

The financing system of China's high-end equipment manufacturing industry is not perfect, and the financing channel is less, so the own funds of enterprises and government funding can't guarantee long-term capital requirements for R&D project, which reduce the R&D process of enterprises to a large extent, increase the gap between domestic equipment manufacturing industry and foreign advanced products.

163.4 Countermeasures for the Development of China's High-End Equipment Manufacturing Industry

163.4.1 Strengthen the Government Security Efforts

High-end equipment manufacturing industry has an important effect on China's technological progress. It is not only related to the industry's own development, but also related to the development of China's national economy. The development level of high-end equipment manufacturing industry directly influences China's development in various fields and relates to the country's economy and national security. Therefore, Chinese government should give some preferential policies to equipment manufacturing industry, increase investment on capital and scientific and technological personnel, establish development policy for equipment manufacturing industry, and promote steady and rapid healthy development for China's high-end equipment manufacturing industry.

At the same time, the government should take appropriate measures to keep the demand of domestic market for the equipment manufacturing industry, to expand domestic demand and drive the development of the domestic market economy. When the cost performances are the same, government should initiatively lead to purchase domestic equipment and facilities. For some well-developed enterprises, government should strengthen the support strength, give low-interest loans, and promote the development of the high-end equipment manufacturing industry. For the enterprises which research and use the first (set) domestic equipment, government should make corresponding rewards, and encourage insurance company to do insurance work for the equipment. In addition, government will cooperate to supervise equipment manufacturing enterprises to speed up for the renewal and transformation of enterprise equipments, make sure that the enterprises have more advanced hardware facilities.

163.4.2 Increasing Spending on Research, Improving Self-Directed Innovation Level

China should increase invests on independent innovation for the equipment enterprises, set up special development fund for the independent innovation and demonstration project of the equipment enterprises, and encourage qualified enterprises boldly to do technology innovation. In some key equipment fields, China should combine with local governments to establish relevant key laboratory, focus on supporting the development of the equipment manufacturing industry.

The research institutes should establish close cooperation relations with universities, use personnel in universities and technical resources, form a combination of research mechanism, and speed up transformation from scientific research achievements to products. China can make a whole set of perfect talent introduction policy and special salary treatment system to those professional talents who master high-end core technology, to attract them to join in R&D team of the high-end equipment manufacturing enterprises (Pei 2010). Meanwhile, we should pay attention to the cultivation of talents, strengthen cooperation and technology exchanges between high-end equipment manufacturing enterprises at home and abroad.

163.4.3 Promoting the Optimization and Upgrading of Industry

China should accelerate the transformation of traditional industries. On the aspect of clean production and energy saving, we can widely use new technology, new process, new material and new equipment to upgrade technology of the traditional industries, speed up industrial structure adjustment within enterprises, and encourage enterprises to carry out merger and reorganization (Liu 2011). The traditional mode of equipment manufacturing industry can not yet adapt to the requirements of the development for modern economy. With the development of economic globalization, China gradually began to join in the world economic competition. To improve international market position, China must speed up to develop modern manufacturing services and strategic new industry, and set up a number of competitive enterprises and famous brand to make sure that China's equipment manufacturing clusters have greater impact in the world.

In the cluster district, government should pay attention to cultivate leading enterprises with brand advantage, with large high-end equipment manufacturing enterprises as the core, driving the development of small and medium businesses around. Each small and medium-sized enterprise gives full play to the collaborative supporting role, consolidates and extends industry chain, realizes the horizontal and vertical radiation of industry chain and expands cluster advantages of the equipment manufacturing enterprises.

163.4.4 Perfect the Investment and Financing System

China should establish and perfect investment and financing mechanism, improve the investment and financing management system, and be clear to the investment direction. The government should make unified management for the investment and financing of the equipment manufacturing industry, formulate unified relevant measures, cast investment and financing mechanism of the equipment manufacturing industry into standardized management, and then form a closely matched organic whole. According to the different use of investment and financing direction and use scope, government can reasonablely make optimization and adjustment to the investment projects. Under the correct guidance of the government, equipment manufacturing enterprises shall foster main role in the market economy, in the meantime, market mechanism and government macro-control can be used to obtain its own development.

Finally, China can set up a special fund to give key support to major equipment programs, set up a supervision committee for special fund use, earmark a fund for its specified purpose only, and eliminate the waste and idle of money. Besides, building the risk control mechanism is a good way to avoid financial risk caused by improper investment and financing. Investment and financing institutions should strictly follow China's laws and regulations, formulate perfect risk control scheme, and strengthen financial risk pre-warning monitoring. If abnormal condition is found, we should immediately report to the relevant government to work out solution measures together.

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Chapter 164
Service-Oriented Manufacturing and the Servicizing Transformation of Chinese Manufacturing Industry

Jun Liang and Ting-ting Huang

Abstract In the global manufacturing industry servicizing trend, Chinese manufacturing industry needs transform to service. This paper firstly elaborates the service-oriented manufacturing connotation and its economic effect, on the basis of that, makes classification researches on the product system, which is the service oriented manufacturing realization platform, and further discusses the condition which manufacturing industry transformation need to satisfy, and the obstacles the manufacturing may encounter in the transformation process.

Keywords Service-oriented manufacturing · Manufacturing industry servicizing · Transformation

164.1 Introduction

Since the Reform and Opening-up, Chinese manufacturing industry has made remarkable achievements. However, with the advance of information technology revolution and economic globalization, constantly rising labor and resource cost, increasingly prominent resources and environmental problems, the transformation of Chinese manufacturing industry whose main characteristics are high energy consumption, high pollution, low added value and low efficiency is imperative. In recent years, within the scope of the world, especially in developed countries, the linkage between manufacturing and service industries has become more and more

J. Liang (✉) · T. Huang
Business School of Shandong University,
No. 180 West Culture Road, Weihai 264209, China
e-mail: liangjunsong@sdu.edu.cn

T. Huang
e-mail: 395482046@qq.com

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close, there is a phenomenon of cross-integration of these two industries. Traditional manufacturing enterprises begin to pay more and more attention to the innovation of its business-related service, and service has become a crucial means of competition. Research date of the world's top manufacturing companies from Deloitte and Touche, in 2006, showed that manufactured goods accounted for only about 30 percent of its sales revenue, while service and parts business accounted for more than 70 %. The level of servicizing of manufacturing industry in developed countries is significantly higher than China; in the United States enterprises having manufacturing and service integration account for 58 % of the total number of manufacturing enterprises, in Malaysia this ratio is 45 %, Belgium is 37 %, while in China enterprises with capability of service-oriented manufacturing account for only 2.2 % of all enterprises. The integration of manufacturing and service industries is the product of further division of the world economic system, and it will cause great changes of the global value chain and repartition of interests and control. Facing the trend of servicizing of global manufacturing industry, Chinese manufacturing industry also needs to conduct service transformation.

164.2 Connotation and Economic Effects of Service-Oriented Manufacturing

Berger and Pappas proposed the concept of Service Enhancement, and pointed out that the service of manufacturing sector had become a trend in developed countries. White proposed the word "servicizing", using this word to describe the trend of manufacturing industry, considered that "servicizing" is a transformation of the manufacturer's role from goods provider to service provider and is a dynamic changing process. Vandermerwe and Rada further used "servitization" to describe servicizing that manufacturing companies which only provide goods or goods with additional services transform to provide "goods-service bundles", complete "bundles" including goods, services, support-service, self-service and knowledge, and service is in a dominant position in the entire "bundles" and is the main source of value-added (Vandermerwe and Rada 1988). Szalavetz thought can use "tertiarization" to express servicizing, specifically including two meanings: one is that internal service efficiency become more and more important for manufacturing enterprises, and part of enterprise competitiveness comes from the effective organization and providing of the internal service; the other one is that for customers, the complexity and importance of the external services related to goods is growing, and service will improved the value of goods and the sales.

Chinese scholars such as Linyan Sun believe, service-oriented manufacturing is a kind of high effective and innovative manufacturing mode which aims to realizing value-added of various stakeholder in manufacturing value chain, through amalgamation of products and services, customer involvement in entire process and enterprises provide productive services and service productions each other to actualizing integration of decentralized manufacturing resources and high degree of synergy of respective core competitiveness and realize an effective innovation manufacturing mode (Sun et al. 2007). This model emphasizing specialty, division, collaboration, is an outcome of mutual support and penetration of the manufacturing value chain and service value chain. In terms of form, the service-oriented manufacturing means that service integrates into the whole process of the product life cycle, such as customer requirement investigation, product design, manufacturing, marketing, after-sales service, etc., or provide customers with personalized total solutions. Service-oriented manufacturing mode enables all links of the value chain as value-added links, and makes the pattern that the traditional manufacturing sector being in the bottom of the "smile curve" mode to change.

The concept of service-oriented manufacturing mainly includes three components: productive services, service production and customer full participation (customer involvement in entire process). Productive services refer to market-oriented intermediate inputs service, which are used for further production of goods and services, non-final consumption services (Wang 2006). Most of the productive services are in the upstream and downstream links of the value chain, expand and extend the traditional manufacturing value chain. Service productions means that enterprises outsource parts or all of the manufacturing sector to specialized manufacturers. Service production activities strengthen the division of labor among enterprises in the middle of the manufacturing value chain, and enable businesses to find a manufacturing resource having comparative advantages, reduce costs, increase production flexibility and reduce risk (Zheng and Xia 2006). Customer full participation refers to the customer involving throughout the production and passing process of manufacturing and service, and having a large number of interactive activities with employees, so companies can find customer demand more quickly. During the procession of customer full participation, businesses and customers can establish a stable relationship forming customer lock-in effect, bitterly dip and share tacit knowledge.

Different from the traditional manufacturing mode, in service-oriented manufacturing mode, there is not a one-time transaction between the customer and the enterprise, but with additional full life cycle services; on the pattern of operation, in addition to the concern of the ways to reduce costs, this mode focus more on demand management and service capabilities, pay considerable attention to knowledge base and knowledge management system which are conducive to knowledge sharing; on the organizational pattern, no longer blindly pursue the vertical integration of the chain structure, but rather focus on the customer, collaboration and interaction between different types of main bodies such as productive service companies, service production enterprises to form a network mode with dynamic structure (Li et al. 2010); service-oriented manufacturing has extended the traditional manufacturing value chain, while shortened the single enterprise's value chain, as every enterprises is focusing more on enhancing its own core competitiveness. Service-oriented manufacturing will bring cost advantage (Yu and Gao 2011), differentiation advantage (Zhou and Yu 2011), environmental effects (Chen and Ye 2009) and economic effects (Gu and Xia 2010), etc.

164.3 Implementation Platform for Service-Oriented Manufacturing: Product Service System

Product Service System, PSS refers to a range of integrated systems of products and services which can satisfy customer demands. Relying on the PSS, service-oriented manufacturing enterprises provide customers with no longer a pure product or service, but "product $\times$ services", thus deliver greater value to customers. The proportion and constitute of products and services in the PSS vary with the type of industry, customer needs, product characteristics, the financial situation of enterprises and technical conditions. According to different degrees of dependence that competitive advantage depends on products or services and whether property right shift in transaction process, PSS can be divided into the following four categories (Sun et al. 2008).

164.3.1 Product-Oriented PSS

In the Product-Oriented PSS (PPSS), after the deal, the ownership of physical products is transferred from the producer to the customer, meanwhile, the customer will get a service agreement related to the physical products to ensure the maintenance, repair and disposal problems of products, The physical product is the core of the enterprise value, and the provision of services to customers is aimed at improving the efficiency and reliability of products. In this mode, the enterprise will price the service business separately, and services have become additional sources of corporate income.

164.3.2 Solution-Oriented PSS

Solution-oriented PSS (SPSS) is to provide customers with a comprehensive solution which is an integration of products and services to meet customer demand to the greatest extent. Service is the main factor to win the market and profit in SPSS. Such services include customized product design, consulting of complete set of solutions, project implementation and management, as well as a variety of services needed in the process of product use. When related services are highly dependent on the product, SPSS provider can take the user lockout strategy to lock the user by low-price products and use high price services to achieve profitability.

164.3.3 Apply-Oriented PSS

In the transaction process of Apply-oriented PSS (APSS), property rights of physical production will not be transferred, still owned by the APSS provider. Customers buy the right to use physical products and associated support services in a certain period of time to meet their own demand. Product quality and cost have a direct impact on customer experience and price, so the physical product is still the key elements of market competitiveness of the APSS. Nowadays, APSS widely present in the following product area with the characteristic of high-tech, high investment, the use of which limited to particular time and region, such as the large medical equipment, engineering equipment, containers and others 1.

164.3.4 Utility-Oriented PSS

In the transaction of Utility-oriented PSS (UPSS), the service producer still has the property rights, while the customer does not use the "product", but directly receive the utility in some form of output, for example, customer purchasing laundry services. The service producer use physical products to provide customers with utility. The UPSS liberates customers from the tedium of learning and the use of complex products, and this is conducive to improving efficiency.

PSS provided by service-oriented manufacturing is not static but in constant evolution. In the beginning of the manufacturing industries, due to lack of experience, in order to reduce the risk many enterprises choose to provide PPSS, after that with the increasing of the service experience, enterprises can begin to provide SPSS or APSS, if the value of the product is relatively small, whether transfer the ownership or not is not pivotal then the differentiation between SPSS and APSS is no longer important, and the UPSS is the ultimate evolutionary target of the PPSS, SPSS, and APSS. Manufacturing companies' provision from PPSS to SPSS, APSS, to the end UPSS is a constantly upgrading process, at the same time, more and more value is created by service. Not all manufacturing companies' transformation need to go through the whole process, enterprises should make choice according to their own characteristics and financial conditions and even for the same products of a particular enterprise, different PSS can be provided to customers with dissimilarity in demand and ability to pay.

164.4 The Basic Conditions of Servicizing Transformation of Manufacturing Industry

Service-oriented manufacturing has many benefits, whether for macroeconomic, resource, environment or micro-enterprises, does this mean that we should encourage all manufacturing sectors and enterprise to implement servicizing transformation? From the practical experience of the developed countries, manufacturing sectors carrying out servicizing transformation have certain characteristics, not all of manufacturing sectors are suitable for the transformation of servicizing.

According to the value differences of physical products and intangible services provided by sectors, manufacturing can be divided into four types, as shown in Fig. 164.1, the different manufacturing sectors have the different manufacturing methods.

For manufacturing sectors which have relatively low value of physical products and intangible services, such as food manufacturing and toy manufacturing, returns gain from servicizing transformation is not high, and they are more suitable for traditional manufacturing mode, through mass production pursuing the scale economy to realize enterprise value.

For sectors like computer manufacturing, household appliance, because of their certain technical content, their physical product value is higher, on the other hand, the operation of those products is less complex, more simple services such as after-sale repairing and maintenance services are needed, therefore, additional value of intangible services is low. Such sectors can only engage in R&D and product design, and carry out mass customization and manufacturing outsourcing, IBM, Haier Group are examples of this kind of successful transformation.

For fashion, furniture and some other manufacturing industries, although the technical content is low, but because the product has the characteristics of short life cycle and fashion, and the customer usually has strong personal special demand, these industries need much more tacit knowledge of the design capability

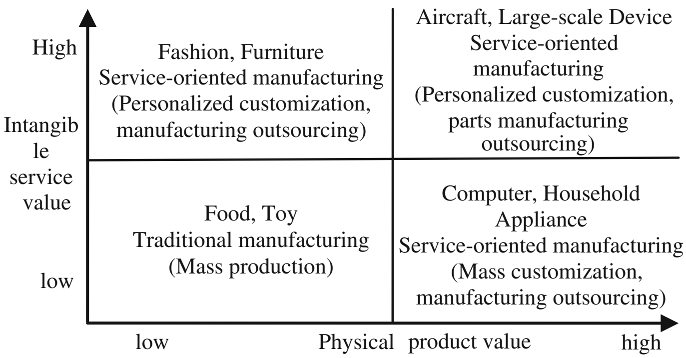

Fig. 164.1 Different manufacturing methods for different manufacturing sectors

and art appreciation based on experience, so those sectors belong to the type with high value of intangible services and low value of physical products and is suitable for customization. They can only provide design services and outsource manufacturing, the Metersbonwe Company is a successful example.

Industries such as aircraft, large device manufacturing, whose physical products have considerable high technological content, complex operation and high degree of product complexity, require more maintenance, repairing and other routine services, should provide services throughout the product life cycle, as a result, both physical products and related intangible services process have the high value. This kind of industries can provide personalized customization according to customer demand, excepting the links of the core technology should be preserved, the rest links, like manufacturing parts can be outsourced, Shaanxi Blower (Group) CO.LTD and General Electric Company are such transformation enterprises.

Through the above analysis, we can conclude that the manufacturing which has transformed into service-oriented manufacturing needs to have the following characteristics: First, the high physical product value due to the high technological content or high complexity of products; second, high intangible service value due to the high complexity, which enterprises need to provide services within the entire product life cycle or need more tacit knowledge or higher design capacity. Only when the manufacturing sector has at least one characteristic and returns from servicizing transformation is relatively high, the manufacturing sector will have the inherent transformation motivation.

164.5 Potential Obstacles of Servicizing Transformation

164.5.1 Obstacles Related to Value Chain

The relationship between the value chain links will hinder the implementation of the strategy of servicizing to some extent (Mont 2002). First, usually servicizing will reduce the number of sales of the product, thereby undermining the interests of the retailers who rely on selling more products to make profits. Second, at the beginning, it is difficult for customers to accept the PSS, in order to enable customers to receive PSS companies need to provide much more attractive solutions, or at least provide products with function equal to the original ones (Meijkamp 1999). What's more, many customers do not know the actual cost of every stage of the product life cycle and thus unwilling to accept the PSS.

164.5.2 Competitive Cost and Operating Cost Obstacles

After transformation, manufacturing companies begin to provide services for customers, this means that the enterprises have entered a new competitive area-service area. There are many competitors in this area, and in order to survive in the new competitive environment, manufacturing enterprises must establish their own competitive advantage which will bring competitive costs (Mathieu 2001). In order to meet individual needs of customers, companies need to provide more modules and channels to keep in contact with customers, and have to establish demand management system and knowledge management system, as a result, increase the operating costs of enterprises. In order to provide better services, companies need to find and identify customer demand and need to offer continual specialized training for staffs to increase their sense of service and their service capabilities, thereby will increase the operating costs. In addition, to provide more services will inevitably bring about the increase in unit labor costs, enterprises have a certain degree of difficulty in measuring costs and value of providing services, and it will take a long time to determine customers' charge standards.

164.5.3 Concerns About Risk

In practice, the risk of servicizing transformation that manufacturers tend to imagined is often much more serious than the actual situation, therefore they sometimes do not willing to internalize the cost of using product, especially in the case that they can't affect the consumers' using behavior. Enterprises will have cash flow uncertainty risk when transform short-term profits from the sale of goods into medium and long term profits from providing services (Oliva and Kallenberg 2003). In addition, companies do not believe that the provision of services can bring additional economic benefits, or the enterprise think providing services may have exceed the limits of their capacity, these matters also will hinder the servicizing transformation (Oliva and Kallenberg 2003).

164.5.4 Organizational Resistance to Change

There is often a conflict of business mode in the enterprise having both products sales and services provided. Servicizing transformation will pose threats to some organizations, when organizations believe service-oriented transformation may change their authority, proprietary technology, responsibilities or resources, they will oppose servicizing transformation (Li et al. 2009). To conduct servicizing transformation, companies must spend necessary costs to deal with and resolve these conflicts.

164.6 Conclusion

Chinese manufacturing enterprises in pass of transformation and upgrading, should closely follow the trend of global manufacturing servicizing, deeply understand the connotation of service-oriented manufacturing, actively create basic conditions for transformation of manufacturing industry, fully estimated the potential difficulties may be encountered in the transformation process, implement the manufacturing servicizing transformation to win economic effect of service-oriented manufacturing.

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Chapter 165
The Upgrading Resistance and Countermeasures of Chinese Manufacturing Industry Foundry Mode

Ying-chun Song

Abstract With the global economic competition aggravating, the problem of China manufacturing foundry enterprise transformation upgrading is imminent. To successfully implement the transformation and upgrading, the manufacturing foundry enterprises must have the profound and comprehensive understanding of the various resistances encountered in their upgrading process and its influence. Different from the most exiting studies, this article firstly elaborates the upgrading mode and possible path of the foundry enterprises, and then analyses detailedly the diversified resistance which different upgrading paths might encounter, and put forwards the coping strategies separately from the enterprises and government point.

Keywords Foundry · Upgrading · Resistance · Dissolve

165.1 Introduction

How Chinese manufacturing foundry enterprises realize their strategic transformation to achieve new developments is the focus of the public concerned. Scholars have made a lot of researches on the upgrading of the foundry mode. From the existing researching results, the majority primarily focused on researching its upgrading need and the path, seldom research the resistance maybe encountered in the process of the transformation and upgrading. For manufacturing companies, the upgrading resistance of the foundry mode is the first factor to be considered and if this factor is ignored, the upgrading target and the corresponding countermeasures will be the empty talk.

Y. Song (✉)
Business School of Shandong University, No.180 West Culture Road,
Weihai 264209, China
e-mail: songyingchun@sdu.edu.cn

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165.2 The Main Foundry Mode and Upgrading Path

165.2.1 The Major Foundry Mode

According to the different nature of the business which the foundry enterprises undertakes, the foundry model can be divided into three levels (Wang and Mao 2007), namely:

1. original equipment manufacturing(OEM).
2. original design manufacturer(ODM).
3. original brand manufacture(OBM).

The main difference between OEM, ODM and OBM is the controlling of designing, manufacturing and marketing value activities. In the context of the international division of labor, different links of value chain generate different added value, so the profitability of the three foundry mode is also different. To use the industry value distribution "smile curve" as analysis tool, you can find that OEM only exists in the bottom of the smile curve and makes the least profit; ODM can obtain the value and profits of the middle part at the left side of the curve; OBM occupies the highest part of the right side of the curve and gains the largest part of the industry profits (Xie and Xue 2009).

165.2.2 The Upgrading Path of Foundry Mode

Enterprises growth is the process of value creation capacity promoting (Zong 2011), so the upgrading purpose of foundry mode is to promote the value chain upgrading, enhance the value creation ability to achieve its competitive advantage sustained and strengthen. In reality, there are two available upgrading paths for foundry companies to choose, namely:

1. *OEM → ODM → OBM.*

In this upgrading path, enterprises need to go through twice transformations. OEM companies need to start with a single OEM producer gradually upgrade to the ODM mode including OEM and ODM; secondly, ODM companies need to design products to meet the demand of contract providers and product these products according to the order. After their R&D design and production function have become mature and their products been adapt to the market environment, the foundry enterprises could get rid of the brand of contract providers and establish their own brands, through the above two steps, they upgrade to OBM mode.

2. *OEM → OBM.*

In addition to the foundry enterprises which use ODM mode as transition, companies can also choose to conduct independent R&D design and self-marketing, to upgrade from OEM to the OBM directly. Of course, considering the cost and efficiency, the OBM manufacturers may outsource assembling, manufacturing and even R&D design business to other OEM or ODMs, and they focus on brand, channel, and after-sale service areas (Guiju 2009) to highlight its own core competitive advantage.

165.3 Analysis on Upgrading Resistance of Foundry Mode

Selecting upgrading paths, foundry enterprises mainly consider the two following factors. The first is the purpose of the upgrading, which usually depends on the strategic objectives of the enterprises. The second is the feasibility of the upgrading, the size of the difficulty of upgrading will directly affect the feasibility of the upgrade program. Here, the word "difficulty" can be understood the resistance in the process of upgrading: the greater the resistance, the greater the difficulty for the OEM mode. Because different upgrading paths of foundry mode have the different nature resistances, and the corresponding solving strategies are different. Having a definite object in view enterprises can realize their strategy targets smoothly. So it is necessary to research the resistance may be encountered in the OEM → ODM → OBM and OEM → OBM these two upgrading paths. In order to facilitate the study, we name the path, OEM → ODM → OBM for path A, especially part OEM → ODM is named path A1, ODM → OBM is named A2; we name OEM-OBM for upgrading path B.

165.3.1 The Resistance that Path A1 May Encounter

ODM success or failure depends on whether company's products can be implemented differentiation on the basis of low-cost, accordingly, the bargaining power of upstream suppliers and product R&D capabilities become the major resistance that enterprises upgrading may encounter.

1. *The bargaining power relative to the upstream supplier's is weak and thus affects the enterprises to reduce production and operating costs.*

Under normal circumstances, ODM have an ability to grasp independently the suppliers raw materials, raw materials prices directly affect the cost of ODM products, thus affect the competitiveness of the ODM enterprise. In the same seller's market conditions of the raw materials, OEM companies can take advantage of the relationship between the agent and raw material suppliers to enjoy a cheap and stable supply of raw materials, but ODM companies are limited by their influence, they often lack of bargaining dominant position. Since the outside factors have great influence on their cost, their profitability ability is more instable.

2. *Passive product R&D resistance to differentiate.*

ODM, in essence, is still based on the Principal Order-oriented, so the focus of ODM companies will continue to operate on the completion of orders rather than take the initiative to develop core technology. The biggest obstacle of the product R&D comes from the configuration of the R&D team, the development based on the innovative products often rely on an independent, full-time R&D team (Great wall Enterprise Strategy Research Institute 2001), the design aimed to complete the order is to rely on a cross-sector temporary team. Although the latter is more suitable to complete the order task and cost less money, it is still not conducive for enterprises to foster core technology, which will be the resistance to upgrade to OBM.

165.3.2 The Resistance that A2 Path May Encounter

Excellent brand enterprise needs to have two characteristics: first, have a powerful brand; second, the brand is continuously and effectively propagandized. Major resistance of A2 path lies in lack of brand building and brand promotion.

1. *Resistance of the experience accumulation exerts on brand building.*

From the world foundry industry, Latin American countries, Japan, South Korea and other countries have a better foundry development history (Gereffi 1999), especially Samsung Electronics, Hyundai Motor and other international famous brands are typical enterprise brand building case. By contrast, the enterprises successful transition to OBM in China is very seldom, except as "the galanz", and "the giant" as the international brand enterprises are fewer, Chinese foundry enterprises lack of the accumulated experience on the brand building.

2. *Resistance of the marketing ability exerts on brand promotion.*

Marketing 4P theory suggests that product, pricing, channels, promotion determines the enterprise's marketing ability, and the foundry enterprises are disadvantage in these links, it is not conducive to brand Propaganda. First, the foundry enterprises operate their own brand with a limited production capacity, their product quantity and specification only covers a small part of the market segments, consumer awareness is lower. Second, the foundry Enterprise compared to the international brand enterprises lack of the scale economies and the cost leadership due to no price advantages to the raw material suppliers, product price disadvantages affect their market demand. Third, the fewer number of distribution channels, lack of sales and product support, consumers cannot enjoy the products and services in time, it is difficult to build brand loyalty. Fourth, limited to the foundry nature and their business capacity, effective promotion type is single and does not provoke potential consumers desire to buy, it is difficult to establish extensive and good social image.

165.3.3 The Resistance that Path B May Encounter

Because the ultimate goal of the A Path and B Paths is reached OBM mode status, there is no denying that the resistance nature of the B Path and A encountered in the upgrading process has a lot of similarity, due to the above two path have the same final value chain, which contains the complete value chain of the R&D, production and marketing systems. Difference between B Path and A Path is B Path missing the ODM transition phase, its value chain almost at the same time to extend to both high profitable ends of the smiling curve, and this feature will highlight the resistance which is not apparent in the A Path.

1. *Resistance from the client.*

In the Path B, the foundry enterprises directly get rid of the client and create their own brand, their relationship become direct competition from the division and cooperation. In the intense competitive industry, relationship change between the competitors is likely to impact on their market share, clients with strong advantages may realize their interests will be reduced in advance and would limit the foundry enterprise's own ability. The entrusting enterprises want the OEM enterprises cooperated with them to enhance their own power to meet the principal enterprise requirements for manufacturing products with low cost and differentiation, but they prefer OEM Enterprise be limited in the original design or manufacturing stage rather than a brand independent stage (Wu 2011). Therefore, they pay particular attention on protecting their competitive advantage barriers, they usually take the frequent replacement of cooperation OEM enterprise or severely limited OEM cooperation areas to make OEM enterprise hard to overcome barriers to learning to improve their own ability. This behavior also can explain why B Path has greater risk than A Path. In addition, the upper reaches can control the cooperation relationship with suppliers due to having negotiation position compared with OBM under the situation of the resource scarcity. If OBM products and supply channels have a strong competition with their clients, clients may participate in limiting the relationship between the vendors and OBM Enterprise, and this situation will be deteriorated due to the raw materials scarcity.

2. *Resistance formed by the foundry enterprises lower management ability.*

The foundry enterprises upgrading through B Path would encounter greater change than the enterprise upgrading by the A Path, if management capabilities are not accommodate with the rapid changes timely enterprise encounter a range of management issues. First of all, from the perspective of strategic management, Enterprise at any time are in a dynamic environment, corporate culture, type of strategic leadership, control systems are in the change, which is huge challenge to enterprises on a growth path of transformation. Second, from the perspective of the business management, cost and human resource management are the two major challenges. (a) Enterprise production cost structures change is most obvious in the path B and most difficult to control. The initial cost of the new business is very small, but with the changes of the cost structure, its growth rate will accelerate rapidly, such as research and development continued investment costs, maintenance costs of the marketing channel, if business cannot control these factors, costs will be out of control. (b) With the function department increasing, companies must reserve human resource through internal promotion or external recruitment, if continuously using the older employees, enterprises will face the problem of lack of professional knowledge to the added function department, if greatly absorbing people from outside, enterprises can meet new business needs, but will face the problem of lack of management experience.

165.3.4 Common Resistance of the Path A and B

1. *The intellectual property rights management is in a mess.*

In recent years, China has intensified its efforts to protect intellectual property rights, but the cases of piracy torts happens frequently, especially high-tech industries such as electronics, software, intellectual property is damaged severely, accelerated the recession of industry product and technology that are frequently updated. The main reason is relevant laws and regulations are not perfect, poor execution, illegal business units and individuals cannot be bound in time, deliberately disrupt the market environment. The worse intellectual property right management has reduced the product life cycle significantly profit ability within their investment period which enjoys the intellectual property right. On the other hand, the threshold of the Chinese patent application was too low and the review is not strict (Xu 2011), which lead to invention flood, serious patented homogenization, smaller difference between many patent product form, characteristic and utility, division markets and pessimism market prospects.

2. *The industry barriers limit entry and exit.*

The entry barriers of the foundry industry is core technology, channel blockade and fund investment. (a) For high-tech industries, patents directly limits the potential competitors from entering the industry, channel blockade will limit the new entrants in the specific market and the capital scale limit enterprise development scale. (b) Upgrading mode of the foundry enterprises has a higher opportunity cost. After OEM business upgrade to OBM, production scale must be adjusted, production cost savings brought about by the scale economies will form part of the opportunity cost. (c) The exit of the OEM enterprises is influenced and limited by the special equipment investment. The greater investment in equipment, the greater the proportion of fixed costs occupy, and the more difficult to exit the industry. (d) To protect the local employment and the industrial structure, the local Government may refuse or discourage the enterprises exit.

3. *The infect of consumer behavior.*

Influenced by the brand popularity and quality, many Chinese consumers are crazy about the foreign things when they buy goods; even facing the same quality goods consumers tend to prefer foreign brands. Using the sportswear industry as a example, the gap on the product properties of "Nike" and "Li Ning" is not very big, but the "Nike" sales is several times per year of "Li Ning". Similarly, the OBM enterprises established their own brands will also face such resistance, unfortunately, if a new brand is lack of effective marketing tools will be more difficult to be accepted by the consumer.

165.4 Resolving Policy of Upgrading Resistance

165.4.1 Do a Good Job of Strategic Transformation Planning

OEM enterprises must conduct a comprehensive analysis about their own abilities and external environment of industry to determine the upgrading paths. In general, it is better for the enterprises which own sufficient funds, operating capacity and are in rapid changes industry to select the path: OEM → OBM. It is secure for other companies to choose this path: OEM → ODM → OBM. After determining the upgrading paths, enterprises need to explore the upgrading strategic objectives and the strategic implementation of programs, and make a strategic transformation preparatory work. Finally, corporate management layer must have strong leadership, decision making and supervision to ensure the real implementation of the strategic objectives and the upgrading process going smoothly.

165.4.2 Focus on the Core Value Chain Links

The upgrading process in the foundry enterprises mode must always focus on the low-cost and differentiation in the value chain. First, foundry enterprises should seize the scarce resources and maintain the good cooperation relations with suppliers, to lay the foundation for directly establishing supply relationships after the upgrading. So both sides should maintain an honest and trustworthy cooperation premise and keep mutually beneficial and win–win collaborative thinking. Foundry enterprises also must pay attention to the maintenance of the supply chain and improvement of the supply channels, to access to cheaper raw materials and lower production costs. Secondly, the foundry enterprises must pay attention to production operations management to improve production efficiency. Because of the increased product diversity, the upgraded OEM enterprises may lose the advantage of the scale economy, so the companies must pay more attention to cost control, take lean production or flexible manufacturing management to increase product differentiation and reduce production costs. Finally, foundry enterprises, in particular, need to concern marketing strategy and brand development. In one hand, enterprises should develop a marketing strategy in line with the overall business strategy, from product, price, distribution and promotion aspects to look for differentiation to meet the needs of more consumers and reduce costs in order to gain more market share; On the other hand, enterprises should also transfer corporate culture and brand culture from the inside to the outside to converted the brand image to the product image, so as to establish the status of products in the minds of consumers and pave the way for enterprises future development.

165.4.3 Seek Strategic Balance in Competition and Cooperation

Porter (1997) pointed out that the existence of the appropriate competitors in the market can bring out many strategic benefits, such as: increasing competitive advantage, improving the current industrial structure, contributing to market development, actively containing the potential competitors from entering. (a) Through producing the product differentiated from the competitors, the foundry enterprises achieve differentiation or innovation, meanwhile, they also can take advantage of the industry leader (which may be the clients) giving their the cost umbrella. (b) The entry of the new foundry companies can exploit the advantage of the bargaining power with suppliers to the full to help improve the buyer's overall bargaining strength and reduce supply costs. Foundries can also act as a market niche role to fill gaps in market segments and help the industry to enhance barriers to entry. (c) The foundry companies can contact with other brands enterprises to share the cost of market development, help technical standardization or legalization and jointly safeguard the industry's image. (d) The competitors can help prevent the threat of potential entrants in the control of the entry barriers and market segments, at the same time, if the resistance of the manufacturing companies in the foundry mode upgrading is reflected sufficiently, which can also be regarded as a strong difficult signal of the industry entry.

165.4.4 *Playing the Role of Government Functions to Create a Favorable Environment for Manufacturing Foundry Enterprises to Upgrade*

Good economic competitive environment is the necessary condition of the transformation and upgrading for the foundry enterprises (Liu 2005). In one hand, the government should strive to improve intellectual property laws and regulations, increase the protection degree on the trademarks, patents, sharply attack the counterfeit and piratic products to encourage enterprises to actively innovate and implement the new mode, new technologies and new products. The concerned departments should raise entry barriers of the patented products, strictly control the patent quality to eliminate the phenomenon of repeated applications of the similar patent. In addition, the government needs to continue to strengthen the degree of concern on the domestic independent brand, such as improving related aid policies, focusing on the quality of own brand products and encourage consumers to buy the independent brand products. On the other hand, the government should deeply introspect "using market exchange technology" strategy and make relevant policies timely to foster and stimulate the market demand to the national products and services to form a strong pull to the transformation upgrading for the local foundry enterprises.

165.5 Conclusion

The transformation and upgrading is the choice which must be faced for Chinese foundry enterprises, accurate grasping all kinds of resistance is the basic premise to successfully implement the transformation and upgrading for the foundry mode enterprises. Their transformation and upgrading cannot complete smoothly only with their own efforts, it need the joint efforts of the enterprise and government. From the point of the enterprise, they should analyze the foundry mode and various upgrading paths accurately, understand the various resistance may encountered in different upgrading paths, make good strategic planning, focus on the core value chain links and do good tactic balance in the competition and cooperation. In order to promote and accelerate the transformation upgrading, the government should strive to create a good market environment for the foundry enterprises.

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Chapter 166
Analysis on Innovative Factors of Influencing Medium and Small Sized Enterprises for Mining Equipment Manufactures

Tong-hua Mou, Chi-dan Ni and Fang Du

Abstract Xiamen Chenggong Ltd is took as case study of small and medium mining equipment enterprises, and technology and economic are considered appreciable influential factors for enterprise to optimize innovation path. Environment and management have less impact. Other factors in order of importance as follows: industry policy, market competition, natural environment, investment in research and development, marketing mode, financial environment etc. The ability to integrate resources, process innovation and marketing model are the advantages innovation capability of sample enterprises. The innovation mode will encounter a problem of lack of competitiveness in technology, patent and marketing mode during its further development. The relevant adjustment on research and development, human resource mechanism and enterprise architecture is necessary to improve technology and patent. The strategy change from resources integration to resources integration and core technology research and development is an important model to expand innovation path for small and medium mining equipment enterprises.

Keywords Innovative models · Medium and small enterprises · China · Australia

This paper is one of research result of the Shenzhen Polytechnic International Cooperation Projects "comparative study of drive mechanism and models for enterprise innovation in China and Australia.

T. Mou (✉)
School of Management, Shenzhen Polytechnic, Shenzhen, China
e-mail: dufang_63@hotmail.com

C. Ni · F. Du
School of Economics, Shenzhen Polytechnic, Shenzhen, China

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166.1 Introduction

Currently, research on innovative ways has mainly focused on three aspects including banks and financing, enterprises and government management, technology innovation and self innovation ways. With regard to research on contents of innovation ways, it has paid much attention on definition of innovation ways and classification, relying on ways and selections of technology ways etc. (Jiang 2002).

Qing-rui (2000) believes that the innovative way indicates the path between different strategies for attaining strategic objectives and attractiveness of future opportunity. Technology path relies on enterprises accumulated advantages and appearing possibilities. From microperspective, Xiao-hua Duan and Ruo-yu Lu has integrated existing resources and capabilities and simplified technology innovation way into two basic types including capacity strengthening type and capacity damaging type. Their research has led to micro and workable directions (Duan and Ruo-yu 2001). Sen-cheng (2004) has explored the path and principles which enterprises should follow for innovations from three layers including regulation innovation, management innovation and technology innovation.

By means of evidence research of scholars Teece and Pisano, there are remains great differences in technology innovation resources and directions of different industries, so do innovation ways. Like industries of chemistry, motor vehicle and electronics, they has owned relatively larger scale whose main innovations have come from the enterprises technology activities and focused on innovations on production techniques and products; by contrast, like small scale industries of machinery and equipment etc., their innovations have mainly involved consumption needs and taken products as their main targets (Teece and Pisano 1994).

However, the above mentioned research has mainly adopted foreign research methods and theories and taken transnational or large scale enterprises as research objectives instead of medium and small sized enterprises (MSE).

Actually, there are great differences on the aspects of innovation mechanism, innovation modes, innovation ideas, innovation ability and innovation environment etc. between large scaled enterprises and medium and small sized enterprises. So are selections of innovation ways.

First, it is impossible to organize research and development group for lack of employees, less research investment and investment channels. Its organization structure needs improvement. However, it has its own advantages. According to research by scholars of Rothwell and Zegveld, MSE's innovation advantages lies on its flexible and concise leader layer structure which makes it faster to make innovation strategies based on the market situation. By contrast, large scale enterprises follow a relatively conservative way. SME has offered a more relaxed management environment for passionate research staff members. In contrast, large scaled enterprises may decrease its employees work passion. Large sized enterprises would offer a promotion to leaders group for research employees. However, small sized enterprises would take innovation as their competitive essence and show great interest to the small innovation programs which may be ignored by large scale enterprises (Rothwell and Zegveld 1985).

Second, traditional manufacturing industries possessed highly matured technologies which mainly come from foreign leading large scale enterprises. It will be copied and produced at a fast speed. Lack of intelligence protect awareness, MSE will hardly compete at the aspect of core technologies.

As for MSE directors, they have played two roles including technology development and management. Its innovative ability and professional background has great influence on enterprise innovations.

All in all, MSE's innovation methods are more flexible and changeable and have many influencing factors. It will not adapt to the research modes of large scale enterprises.

Enterprise innovation ways' research should pay much attention on whole effects of innovation ways to attain enterprise strategic objectives, how to establish innovation ways, whether innovation ways would match current resource and whether helpful to upgrade innovation abilities in enterprises. If the answer is positive, this innovation way is the right choice, and vice versa.

Thesis' structure is as following: first, research on analysis of current enterprise innovation situation, proposal on existing problems. Based on this, propose factor integration methods of innovation ways selections, which helps MSE select enterprise innovation ways, set up innovative objectives and offer new ways of thinking for innovation ways by means of visualized and practical modes. The third part involves analysis on core problems of factors combination including influencing factors of enterprise innovation, its influencing extent and its competitive strength etc.; finally, it will take mining equipment manufacturing enterprises as an example.

166.2 Factor Combination Methods of MSE Innovation Ways' Selection

By research on the characteristics and rules of MSE's innovation activities, this thesis has carried out special program investigation and analysis on the innovation activities in MSE of mining equipment manufactures and proposed "factors combination method" which will help enterprises select innovation ways in a dynamic and optimized adjustment way of being practical and visualized.

It adapts the following ways: (1) analysis and selection of MSE's innovation influencing factors; (2) confirmation of each factor's influencing extent to enterprise's innovation; (3) confirmation of competitive strength of influencing factors; (4) selection of enterprise's innovation starting point(taking factor competitiveness strength as criteria, integrated factor influencing strength, organize innovation ways); (5) Dynamic adjustment of innovation ways, mainly focused on improvement of low-competitive and high-influencing grade factors.

There are three components of factors' combination methods: selection of core factors, confirmation of factors' influencing strength and competitiveness and selection of innovation ways.

The influencing factors refer to outer and inner influencing factors in enterprise's innovation activities, which might be different in different industries, different scaled enterprises and different development stage. Even the same influencing factor might have different significance (influencing strength) and competitiveness. Thus it is critical to confirm the selection of factors.

The influencing strength and competitiveness have reflected the significance and advantages of innovation factors in enterprise's operation and innovation activities. By means of mathematical statistics method, we could confirm the influencing grade in different enterprises, selection of innovation ways and logically organize relevant factors under the guidance of enterprise innovation strategies.

The following part is to introduce the core contents' research methods of factors' combination methods.

166.3 Innovating Influencing Factors Analysis in MSE

166.3.1 Selection of Enterprises' Innovation Influencing Factors

With regard to the complexity of enterprise innovation itself, there will be different influencing factors for the optimized selection. Foreign and domestic scholars have mainly focused on three factors including innovation investment, innovation management and produce technology levels (Sun 2007, 2008). Steek and Lowell have done research on how resource conditions, manufacturing demands and innovation organization influence innovation ways (Steek 1994; Ransley and Roges 1998) have proposed how technology strategy, innovation management, core ability and researcher influence enterprise innovations' ways and effects. Wu (2000) has done research on how investment ability, research how development ability, produce ability, marketing ability and management ability influence the selection of optimized innovation factors. This thesis will carry out research on influencing factors of enterprise innovations ways' selections, with regard to the characteristics of MSE of mining manufacturing industries.

Furthermore, in the research field of enterprise innovation system and evaluation index system establishment of enterprise innovation ability etc., it has already stated the influencing factors of enterprise innovations.

Bing Sun has systematically done research on the motivation of enterprise technology innovation in "Research on the Motivation of Enterprise Technology Innovations" (Sun 2003). It has been classified into outer motivation and inner motivation. Outer motivation consists of market demand motivation, market competition pressure, science technology support and government support with twelve detailed sections. Inner motivation includes enterprise benefit-driven motivation, enterprisers' spirit, and enterprise culture and enterprise inner motivation system and enterprise innovation ability along with 18 detailed sections (Lv and Jin-qing 2009). Wei-min Zhu and Di-fang Wan believe that there three layers including technology, organization and strategies with the support from rules, enterprise culture, talents, capital and information etc. (Zhu and Wan 1999).

With respect of three-dimensional structure model of enterprise innovation field, there are resource dimension, ability condition dimension and environment condition dimension. Resource condition dimension includes human resources, culture resources, organization resources, object resources and information resources; ability condition dimension includes technology advantage ability, knowledge and organization innovation ability, entrepreneur's innovation ability, enterprise strategy innovation ability and brand recognition ability; environment condition dimension includes science environment, talents' environment, policy environment, market environment, legal environment and industry environment (He 2006).

The above discussion has offered the ways to analyze the influencing factors of enterprise' innovation. According to the industry and scale of targeted enterprise, we could build specific matrix of different influencing factors. Obviously, there existing great differences between high-tech industry and traditional manufactures, large scaled enterprise and MSE on the aspects of innovation modes, innovation management and innovation contents. Therefore, their innovative impact factor will be different.

This thesis will combine the above mentioned research accomplishments and propose detailed influencing factors list in the forth case study part according to national MSE of mining equipment manufactures (Jiang 2010).

In order to guarantee the correctness and comprehension on the selection of influencing factors, we could select the influencing factors confirmed by Delphi method for the first time as follows:

1. Select experts. Experts should be equipped with solid knowledge foundation, rich experience and knowledge of current industry development. According to international standards, the number of experts should be between 20 and 35 who are representatives in this field.
2. Select alternative influencing factors and design questioners. Ask experts to judge the influencing extent of alternative influencing factors in national MSE export equipment manufacturing enterprises.
3. Research, analyze and calculate the questionnaires returned by experts.
4. Select the alternative influencing factors.

Select the alternative influencing factors. If the valid returned questionnaire quantity is M, the i of influencing factor is $X_{i,}$ and the number is m_i selected by experts, then there are m_i number of experts believe X_i is innovation influencing factor. Suppose $r_i = m_i/M$, if r_i value is large, it indicates this factor has great influence which should be kept and be a formal factor. Vice versa. According to experiences, this thesis has chosen $r = 0.5$ as the marginal value and value of being $r > 0.5$ is the enterprise innovation influencing factor.

166.3.2 Confirm the Influencing Extent of Factors

In order to confirm the extent, we could apply Analytic Hierarchy Process (AHP) to rank the importance order in a relatively way (Satty 1980). Obviously, rank frontier, indicate more important. The details steps are as follows:

1. Build recursive class chart.
2. Construct judge matrix of Standard layer and factor layer and compare the importance of the factors on the same layer. Apply Saaty 1–9 Scaling to evaluate.
3. Consistence test of judge matrix by introduce average random consistence index of RI test.
4. General rank. First judge Characteristic root of matrix A's solving ($AW = \lambda_{max} W$) and its solving is W. After normalization, we will get rank weights of specific factor's importance order named single order of layers. Then calculate all the factors' importance order on one layers compared with the general objective on the top level named general layer's ranking order.

166.3.3 Confirm Factors' Competitive Strength

We could apply experts' scoring method to confirm the factors' competitive strength. We may integrade a final score based on experts' different points. However, experts might be subjective and extreme during the scoring process. In order to solve this problem, we have applied the majority of aggregation of Majority Additive-ordered weighting a verging to confirm the score of each program to confirm each factor's score. Operator of MA-OWA is the development of group decision OWA operator. This method has evaluated larger weights for the same opinions by the different experts in order to avoid the influence of extreme points (Pelaez and Dona 2003).

The process of majority of aggregation algorithm is as follows:

1. Clarify experts' scores according to the number and differences of each point;
2. Select and average one number from each kind. Define the average as one kind;
3. Subtract one number from each kind (not included the second mentioned average). Delete the group of the zero number of points;
4. Return to B and repeat steps of B and C until only one classified group left. At the same time only one factor is left in the group which is the value of gathering different experts' suggestions.

The math description of realizing the above mentioned steps:
Define operator of MA-OWA as:

$$\begin{aligned} \mathrm{F}_{MA}(a_1, a_2, \ldots, a_n) &= \sum_{j=1}^{n} \omega_j b_j \\ &= \sum_{j=1}^{n} f_j(b_1, b_2, \ldots, b_n) b_j \end{aligned}$$

a_i (i = 1,2,…,n) is to be assembled of experts evaluation value, b_j is a_i 's the largest number of j.

$\omega_j \in [0, 1]$ 且 $\sum_{j=1}^{n} \omega_j = 1$.

$$\omega_j = f_j(b_1, b_2, \ldots, b_n) = 1/\prod_{k=g_j}^{n} h_k(b_1, b_2, \ldots, b_n)$$

:g_j is the number rank of the original data's order. For example, as for {3, 3, 2, 2, 1, 1, 1}, rank as {1, 1, 1, 2, 2, 3, 3}, then $g_j = \{1, 2, 3, 1, 2, 1, 2\}$.

Calculation method of h_k:

$$h_k(b_1, b_2, \ldots, b_n) = \begin{cases} \sum_{j=1}^{n} p_{kj}, & \text{if k} = 1; \\ \sum_{j=1}^{n-k+1} p_{kj} + 1, & \text{if k} \neq 1 \end{cases}$$

$$p_{kj} = \begin{cases} 1, \ \text{if } b_j = b_{j+\mathrm{k}-1}, & \text{even } b_j \neq, \ b_{j-1}, \ \mathrm{j} \neq 1; \\ 1, \ \text{if j} = 1, \ \text{even k} \geq 1, & b_j = b_{\mathrm{k}}; \\ 0, \quad \text{other situation} \end{cases}$$

166.4 Case Study

This case study has focused on Xiamen Chenggong Equipment of Ore CO., Ltd, which is a typical MSE of mining system integration, equipment sales and techniques design.

Even though it is a small scaled company, it has unique methods of produce techniques, whole-equipped integration, marketing modes and market services etc. Study on this company's innovation features and ways has typical meanings for MSE's innovation activities.

According to model organizing mode, we will introduce selection of innovation ways and optimized steps in Case Study Company.

166.4.1 Analysis of Influencing Factors of Enterprise Innovations

With reference of other scholars' research accomplishments and integrated national MSE's mining industry features, this thesis has design the influencing factors of affecting national MSE's mining equipment manufacturing enterprises' innovation by deep investigation of enterprises and industries. The factors have 16 items of four categories such as economic factor, environmental factor, technology factor and management factor etc.

In order to avoid repeated selection and wrong selection, first select the influencing factors by Delphi method. This thesis has selected 20 experts in national mining enterprises; academic research organization and higher-learning colleges, among whom there are 10 entrepreneurs, 4 academic organization experts, and 6 teachers in higher learning colleges. They will evaluate and judge the influencing factors towards national mining equipment enterprises. We have distributed 20 questionnaires and returned 20. Based on the analysis of the questionnaires, the values less than 0.5 refer to enterprise culture and enterprise scale which should be deleted. Thus, we may see the influencing factors of enterprise innovations listed in the first and second volume in Table 166.7.

166.4.2 Confirmation of Factors' Influencing Strength

Applying layer analysis method, we have rank the influencing factors in order to confirm the importance of each factor.

Apply layer analysis to rank the influencing factors for importance. This thesis has applied AHP method. Influencing strength will be determined by combination weights value.

1. Innovation influencing factors of mining equipment manufacturing enterprises mainly involve in economic factor, environmental factor, technology factor and management factor which will be fully reflected in sub-factors. Hierarchical structure model shows in the first and second volume of Table 166.7.
2. Based on enterprise's investigation result, construct judge matrix of Standard layer and factor layer and compare the importance of the factors on the same layer. Apply Saaty 1–9 Scaling to evaluate (Tables 166.1, 166.2, 166.3, 166.4, 166.5).

Among them, $\lambda_{\max}$ refers to the largest characteristic root, CI refers to consistence index

$$\mathrm{AW} = \lambda_{\max}\mathrm{W},\ \lambda_{\max} = \sum_{i=1}^{n}\frac{(AW)i}{n\mathrm{Wi}}$$

Table 166.1 Standard layer matrix A

A	A_1	A_2	A_3	A_4	W_i	λ_{max}
A_1	1	1/3	1/7	3	0.0973	401,756
A_2	3	1	1/5	3	0.1833	
A_3	7	5	1	9	0.6667	
A_4	1/3	1/3	1/9	1	0.0527	

factor layer A_1–A_4

Table 166.2 Factor layer matrix A_1

A_1	A_{11}	A_{12}	A_{13}	W_i	λ_{max}
A_{11}	1	3	1/2	0.3487	3.1356
A_{12}	1/3	1	1/2	0.1677	
A_{13}	2	2	1	0.4836	

Table 166.3 Factor layer matrix A_2

A_2	A_{21}	A_{22}	A_{23}	A_{24}	W_i	λ_{max}
A_{21}	1	1/9	1/5	1/7	0.0389	4.1702
A_{22}	9	1	5	4	0.5996	
A_{23}	5	1/5	1	1/2	0.1377	
A_{24}	7	1/4	2	1	0.2239	

Table 166.4 Factor layer matrix A $_3$

A_3	A_{31}	A_{32}	A_{33}	W_i	λ_{max}
A_{31}	1	1/2	2	0.3108	3.0536
A_{32}	2	1	2	0.4934	
A_{33}	1/2	1/2	1	0.1958	

Table 166.5 Factor layer matrix A $_4$

A_4	A_{41}	A_{42}	A_{43}	A_{44}	W_i	λ_{max}
A_{41}	1	9	1/4	1/2	0.1698	4.2937
A_{42}	1/9	1	1/9	1/7	0.0338	
A_{43}	4	9	1	4	0.5710	
A_{44}	2	7	1/4	1	0.2255	

$$\mathrm{CI} = \frac{\lambda\mathrm{max} - \mathrm{n}}{n - 1}$$

$(AW)i$ refers to Vector A I 's factor in W

3. Consistence test of the judge matrix

Tell whether the judge matrix offers a satisfying consistence. We need to introduce average random consistence index RI. As for 3rd and 4th judge matrix, RI: 0.58 and 0.90.

Calculate the consistence ratio, CR = CI/RI, shown as Table 166.6.

All value of CR is less than or near 0. 10, thus the above matrix is satisfying.

4. General rank of all layers

For general rank, first judge Characteristic root of matrix A's solving ($AW = \lambda_{max} W$) and its solving is W. After normalization, we will get rank weights of specific factor's importance order named single order of layers. Then calculate all the factors' importance order on one layers compared with the general objective on the top level named general layer's ranking order. This thesis result is shown in the 7th volume of Table 166.7 and rank in the 8th volume.

166.4.3 Confirmation of Factor Competitiveness Strength

First, invite 10 experts score each influencing factor according to enterprise's specific situations, among whom there 4 enterprise innovation scholars and 6 enterprise leaders and technicians. Apply the majority of aggregation algorithm to deal with the statistics. The ranking order of factors' competitiveness is like the 9th volume in form 7.

166.4.4 Result

From the above ranking order on standard layer A_i ($i = 1, 2, 3, 4$), we could tell the ranking order of the influencing extent is technology factor (A_1), economic factor (A_2), environment factor (A_3) and management factor (A_4). Technology and economic factors have significant influence on the optimized selection of enterprise innovation ways. However, environment and management factors have less influence. Enterprise research has proved that technology and economic factors play a direct role in enterprise innovation activity and environment and management factors have played an indirect role.

From the influencing factor strength, the largest weight is technique flow A_{32}, is 0.3290; the second is resources combination (A_{31}), is 0.2072; special technology and patents (A_{33}) rank the third, is 0.1305. The above result indicates technology factor plays a core role among others.

Table 166.6 Matrix consistence ratio (Cr)

CR	CR_A	CR_{A1}	CR_{A2}	CR_{A3}	CR_{A4}
Value	0.0650	0.116	0.0630	0.0462	0.1088

Table 166.7 Innovation influencing factors in mining manufacturing enterprises

Standard layer	Factor layer	A_1 0.0973	A_2 0.1833	A_3 0.6667	A_4 0.0527	Combination weights	Rank of influencing strength	Rank of competitive strength
Economic factor (A_1)	R & Dinvestment(A_{11})	0.3487				0.0339	7	10
	Sales investment (A_{12})	0.1677				0.0163	10	9
	Market competition(A_{13})	0.4836				0.0471	5	8
Environment factor(A_2)	Market information(A_{21})		0.0389			0.0071	13	6
	Industry Policy(A_{22})		0.5996			0.1099	4	4
	Financing environment(A_{23})		0.1377			0.0252	9	12
	Natural environment(A_{24})		0.2239			0.0410	6	13
Technology factor (A_3)	Resources integration ability (A_{31})			0.3108		0.2072	2	1
	Techniques flow innovation (A_{32})			0.4934		0.3290	1	2
	Special technology and patent (A_{33})			0.1958		0.1305	3	11
Management factor(A_4)	Entrepreneur features(A_{41})				0.1698	0.0089	12	5
	Enterprise organization structure (A_{42})				0.0338	0.0018	14	14
	Marketing mode(A_{43})				0.5710	0.0301	8	3
	Human resources system(A_{44})				0.2255	0.0119	11	7

From influencing factors' competitiveness advantages, the first three ranks are resources integration ability, technique flow innovation and marketing mode, which are the advantage and unique innovation abilities of the enterprise.

166.4.5 Selection and Optimization of Enterprise Innovation Ways

At present, MSE equipment enterprises include equipment manufacturing enterprise and producing specific type of mining equipment. In China, most of them are equipment for mining, digging, fracture and selection with low skills; so large scaled enterprises are able to do research and development on technology, techniques flow design and equipment accumulated services. Xiamen Chenggong Equipment Of Ore CO., Ltd cherished this feature. Due to the three advantages, it has designed a successful innovation ways.

It has owned the most design data base with regard to the technique flow and owned more than one thousand sets of designs, which is able to meet different requirements of each client. With respect of resources integration, it has formed stable equipment supplies, technology sharing and supporting abilities with alliance of golden equipment design research academy, mining machinery factory and mining machinery manufacturing enterprise. On the aspect of marketing mode, it has focused on adapting to national mining resources strategies, develop the African and Asian markets and adopt cooperation mode of technology, equipment and management. It has successfully entered several countries' market and cooperated with local enterprises to develop the local market.

The above mentioned innovation mode has achieved great success but faced many problems for further development as well such as technology and patents, lack of competitiveness in marketing mode, which should be strengthened for optimizing enterprise innovation. If technology and patents advantages need upgrading, then human resources system and enterprise structure will need adjusting. If marketing mode needs refreshing, then industry policy, market information, financing policy and natural environment etc. need increasing competitiveness. Transforming resources integration to combination of resources integration and R&D of core technologies as the main innovation strategy will lead the enterprise become larger and stronger.

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Chapter 167
Resolving Complex Management Problems on the Basis of TOC Thinking Process and TRIZ Innovation

Sheng-long Jin

Abstract Defining and resolving core conflict in a system is critical in building a creative solution to complex problem. TOC thinking process is an effective tool to analyze a complex system and to find out the core conflict. TRIZ theory is another useful tool to resolve conflict and to propose creative solution. Although they are from different fields, however, both focus on resolving contradiction and complement each other. This paper discusses complex problem-solving thinking model and shows how mutual integration of both TOC and TRIZ thinking process can be used in the process of complex management problem-solving. The combination of TOC and TRIZ thinking process can significantly improve a company's capability of resolving complex management problem.

Keywords Conflict · Injection · Innovation · Thinking process

167.1 Introduction

For many companies, running business will face various kinds of problems. How to resolve these issues is the key to sustainable and healthy growth. Many companies solve contradiction with compromise method and seldom apply creative thinking. Through the practice of management improvement and innovation, it is found that the application of system and innovative thinking method can significantly enhance a company's capability in solving contradiction. Problem-solving process need to find out the core conflicts, to re-examine the assumptions behind the conflicts, and to put forward creative solutions with innovative thinking method. TOC thinking process put forward three questions, they are: "What to change?", "What to change to?", "How to change?" (Scheinkopf 1999). Dettmer

S. Jin (✉)
Shanghai Electric Power Generation Group, Shanghai, China
e-mail: jinshenl88@hotmail.com

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(Dettmer 2007) introduced various methods to define and evaporate core cloud. Altshuller and Genrich proposed innovative principles and theory to resolve conflict (Altshuller 2008). Edward de Bono proposed lateral thinking, making people getting out of thinking inertia (De Nono 2006). These theories make people analysis and resolve conflict in a systematic and innovative manner. TOC thinking process and TRIZ approach have their own weaknesses. A combination of TOCTP and TRIZ innovation theory can provide an effective methodology to find creative solution and to manage complex contradiction.

This article introduces the thinking process framework of complex management problem solving, and with the assistance of case studies, presents the methods to apply thinking process to solve complex business problems.

167.2 The Basic Model of Thinking

Defining and resolving core conflict in a system is the key to find creative solution to complex problem. First, analyzing the current status of a system, then determining the problems in a system, then finding out the root problem, and to consolidate the core cloud conflict (Core Cloud Conflict). Secondly, resolving the conflict and seeking win–win solution by applying innovative thinking approach. Finally, determining basic prerequisite of implementation of the solution, and to find out the possible negative effects, building a logical and practical road between the improvement measures and organizational goals. The thinking process is as shown in Fig. 167.1. Here we will more deeply discuss how to find out a creative solution.

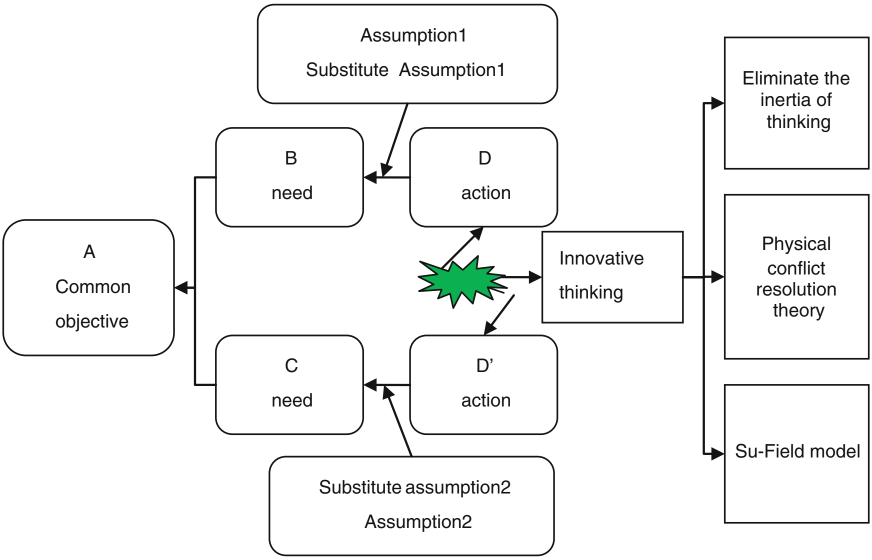

Fig. 167.1 The basic model of thinking

Finding creative solution need to eliminate thinking inertia and to keep a beginner's mind. Typically use nine window, dimension-time–cost (DTC) operator (Orloff 2010), and lateral thinking (De Nono 2004), to change the direction of thinking. Physical contradiction solving theory has four principles, which are, time separation, space division, the characteristics of segmentation, and local and overall split (Tan 2010). Applying these principles can reduce the range of contradiction, and make people easily focus on the core problem. We can also modify the Su-Fi model in finding a solution (Altshuller 1994). Innovative thinking is a divergent process. Good solution need to compare, to select, to combine good ideas, and to substitute existing assumption with new assumption. The following case demonstrates how to use physical contradiction solving theory to solve complex management problem.

167.3 A Management Innovative Case: Agile Logistics Management Model

Agile logistics is a basic requirement for operation in changing market. TOCTP is an improvement methodology for the supply chain improvement (Husby and Swartwood 2009). This case discussed how to apply TOCTP and TRIZ, build an agile logistics management mode in a large-scale equipment manufacturing enterprise in Shanghai Electric Corporation.

In recent years, business of this company increased significantly, but the quality of operation has not been enhanced in synchronization and inventory level is rising, resulting in increase of fund used. How to improve the logistics system and to improve the quality of operation is becoming important issue. First, we analyzed the current situation. Through communication with relevant department and people, we found eight Undesired Effects (UDEs) exist in the logistics system as follows:

- High inventory levels of raw materials
- Some of the items are not moving
- Matching items often not be in place on time
- Frequent emergency procurement
- Frequent material scrap
- High inventory cost
- Procurement of goods is not accurate
- Sometime effect on stable production

167.3.1 Identify Core Conflict

For identifying the core conflict, we select three UDEs, they are "high inventory levels", "procurement of goods is not accurate" and "matching items often not be

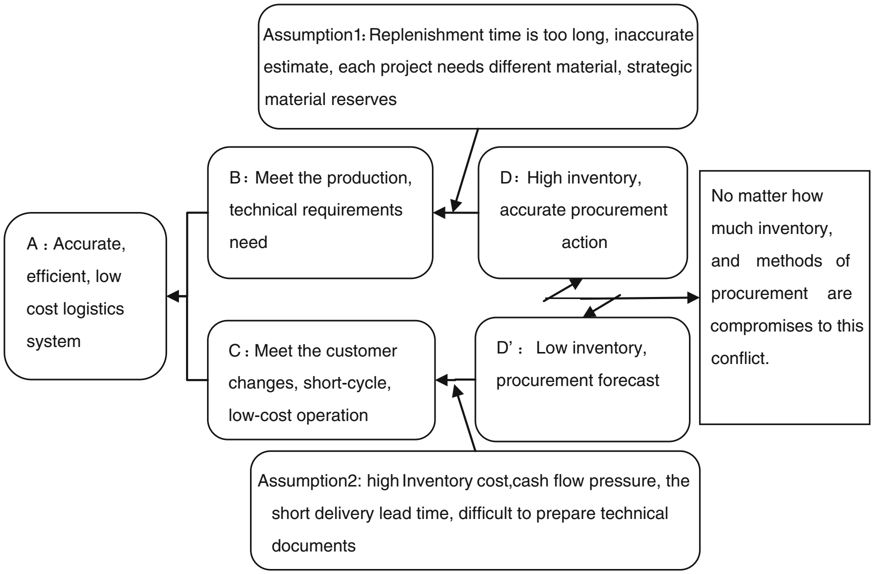

Fig. 167.2 Core conflict cloud

in place on time". Through analysis and consolidation, the core conflict cloud is identified and is as shown in Fig. 167.2.

The core conflict in the logistics system is: "the high inventory, accurate procurement" and "low inventory, estimated purchasing" conflict. The core conflict led the enterprise facing management dilemma.

167.3.2 Resolve the Core Conflict

Thinking inertia makes people stay in the habitual mode of thinking. First, we should break the thinking inertia and to possess a beginner's mind. Secondly, applying innovation theory to find a creative solution, amend the original assumptions. This conflict has the opposite D and D', so it can be refer to physical conflict, therefore we apply the physical conflict resolution theory to solve this conflict.

1. Apply the time separation principle

The accuracy of procurement depends on the time of the materials need. According to the principle of time separation, pre-action principle (inventive principle 10) and the vibration principle (inventive principle 18), as a major innovation principles applied seeking solutions.

Injection 1: Freeze the material needs of a certain period of time. According to the pre-operating principle, planning department freeze the material needs of a certain time period, ensure the match between the material procurement and demand.

Injection 2: Priority of technical data for procurement. According to the vibration principle, determine the priority of technical data for early procurement, and enhance the frequency of communication between departments, to form a collaborative mechanism.

2. apply condition separation principle

The difficulty of procurement and the length of delivery cycle time is dependent on material item. Some materials are seller's market, and have long lead time, it is difficult to purchases according to the order. According to the principle of condition separation principle, select the partition principle (invented principle 1), the feedback principle (inventive principle 23) and reverse action principle (inventive principle 23), as main principles of innovation (Fig. 167.3).

Injection 3: the material classification. According to the segmentation principle, materials divided into strategic goods and non-strategic goods, the definition of strategic resource is those difficult procurement goods in global. Company should focus on strategic resources, long lead time materials.

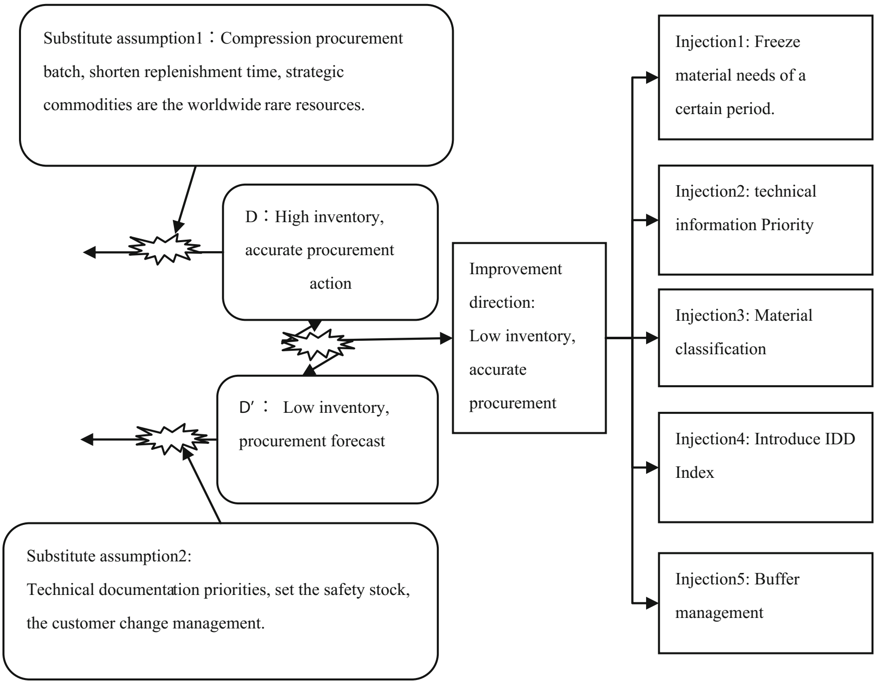

Fig. 167.3 Evaporate core cloud

Injection 4: IDD measurement index. According to the feedback principle, set IDD measurement index. Although, this company has inventory assessment method, but not precisely calculate time value of inventory. The mean of IDD is the amount money of inventory multiplier stock time. IDD is an accurate measurement index measuring efficiency of the logistic system, provide important information for continuous improvement.

Injection 5: buffer management. According to the reverse action principle, increase inventory of some material items, setting safety inventory and safety purchase lead time. Buffer management mechanism improves ability of matching between inventories, accelerate material flow, and enhance the logistics system flexibility and agility.

3. Resolve the core conflict

Amend original assumption is the key to resolve core conflict. The Substitute assumption1 is, "Compression procurement batch, shorten replenishment time, strategic commodities are the worldwide rare resources"; Substitute assumption2 is "Technical documentation priorities, set the safety stock, the customer change management". Change assumptions evaporates core conflict, appears opportunities for improvement. The improvement direction is "low inventory, accurate procurement".

167.3.3 Planning the Future Reality Tree

Build future reality tree need to consider impacts produced by injections. The future reality tree demonstrates the possibility vision of future, enable people to share common vision (Dettmer 2003). These injections will change the operation mode, and make original undesired effects (UDEs) change to desired effects (DEs) (Fig. 167.4).

Implementation of the solution needs to overcome various obstacles, and negative effects. In this case, the most difficult obstacle is to overcome obstacle of "accustomed past management method, didn't will to accept new method"; the most important negative effect is the "inventory reduction affect the production needs". We should take pre-action to overcome such obstacles and negative effects.

167.4 Evaluation of the Solution Results

Implementation of solution achieved significant results. Inventory reduced significantly, logistic operation mode became agile and flexible. In order to ensure the objectivity of the result, financial department involved whole process of project. The results of the solution are as follows:

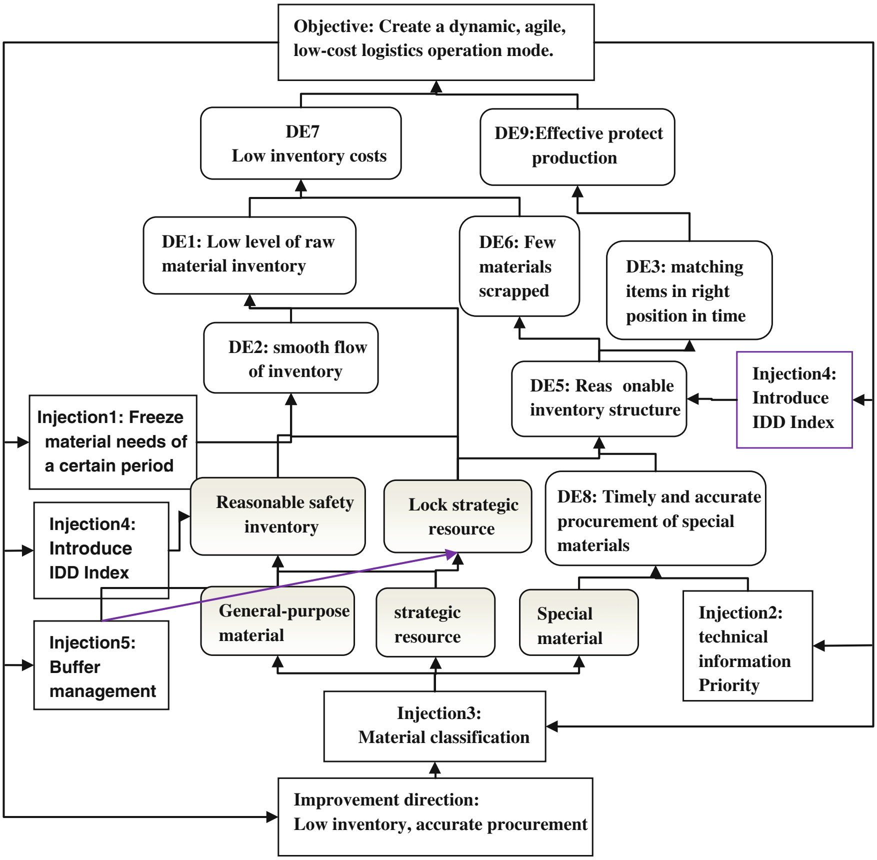

Fig. 167.4 Future reality tree

(a) *Significantly reduced inventory and cost of logistics operation.* Within half year, inventory reduced from the initial 1.984 billion Yuan RMB, down to the inventory 14.6661 million Yuan RMB, total reduced inventory is 517 million Yuan, decreased 26 % inventory, canceled an external warehouse, reduced storage costs.

(b) *Establish a transparent material management system.* Application of IT technology build a transparent logistics system, can easily obtain IDD index change, and accurately response to the change demand.

(c) *Trained a number of logistics management experts.* Depth discussion, research, questioning, and overthrow assumptions, all these process improved team members' skill of analyze and problem-solving, and enhanced logistics management capabilities.

167.5 Conclusion

The combination of TOC thinking process and TRIZ innovation can accurately define core conflict in a system and propose creative solutions. We find in some companies, with almost the same hardware, the result of their business performance can be quite different. Such difference arises mainly from their thinking process and how the existing assumptions are challenged.

In a real world, since business environment is constantly changing, the basic assumption of the business is also changing continually. We need questioning, and challenging premise assumption of business, and implement innovative solution to breakthrough business dilemma. Continually improvement and innovation can significantly enhance company's management capability and performance.

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Chapter 168
Geographical Distribution of FDI-Based Innovation Activities in China: The Innovation Issues

Hong-ru Wu

Abstract Foreign direct investment (FDI) geographical distribution movement is discussed by scholars. FDI innovation issues or investment quality issue is not discussed. About FDI technology and innovation activities generated by FDI movement, this paper deals with this FDI-based innovation activities issue about Chinese economy. This paper makes a summary of researches about FDI movement, devises framework of FDI-based innovation activities and a related evaluation system, including a conceptual analysis of FDI-based innovation activities based on the FDI characters in China. This paper also researches FDI-based innovation activities of 31 regions and cities in China.

Keywords FDI · Geographical clusters · Innovation activities · Technology

168.1 Introduction

Recently geography studies have two streams; the first one is about location character of innovation activities. The second one concerns geographical clustering of FDI movement. China, as the world second largest FDI host country, opens to the world economy. The changes are two aspects. At first, larger amount of investment from developed countries since 1992, indicating stronger commitment and longer term strategy for China market by those international companies. Secondly, heavier R&D investment into China from large MNEs, typically from Fortune 500 companies, since 1994, implying that clustering of FDI can be active not only in terms of production, but also through knowledge generation. Through a study on FDI-based innovation activities, this paper is aimed to answer following

H. Wu (✉)
School of Economics and Management, Panzhihua University Sichuan,
Panzhihua 617000, People's Republic of China
e-mail: studystudent@sohu.com

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three questions. Firstly, what is the situation of geographical pattern of FDI innovation activities in China, in terms of innovation contents. Secondly, is there any closer links between local industrial innovation issues and FDI movement in different regions. And thirdly, regarding research-based innovation is there still significant connections of local innovation to FDI movement and FDI-based Innovation Activities?

168.2 Literature Review

From current research literature, it is clear that both innovation activities and FDI movement need certain environment of economic development. De Bresson et al. (2010) mentioned that the nature of clustering of research based innovation in some way connected to existing economic development and this relationship would determine ways by which firms or research agents can learn and create knowledge. On the other hand, in terms of individual company, research shows that technology activities in regional firms are dependent on both existing technology competence (such as the gap between the old and the new technology, by Nelson and Winter (2002) and overall industrial activities, specially the influence from the main firms' production (Patel and Pavitt 2003).

In fact, knowledge density of particular technology is mentioned as significantly important for the technology diffusion in certain region. Porter's theory (2010) shows that the geographical clustering of innovators and early adopters of new technology stimulates and also facilitates imitation and improvement. The present papers argue that the diffusion of new technological processes may occur faster in geographical areas where the density of sources of knowledge about such technologies is higher.

In recent years, research regarding geographical nature of innovation activities also shows that research based innovation activities are strongly geographically bounded. For example, studies by Feldman (2004), Audretsch and Feldman (2006) reveal that R&D activities as well as other knowledge sources are concentrated in the particular region. They suggest that although knowledge spillover is possible, this spillover movement is rather bounded in specific regions (Feldman 2004; Audretsch and Feldman 2006).

MNEs behavior in research investment worldwide in recent years also shows that knowledge diffusion through R&D internationalization is rather knowledge sharing type than knowledge controlling type, which is primarily indicated by gradually increased roles of subsidiaries and interdependent networking of related subsidiaries within MNEs, and large MNEs began more and more relying on their overseas production as well as knowledge clustering networks, rather than previous pattern of totally centered R&D institution in the home country (Kim and Hwang 2003). Head et al. (2005) studied the FDI movement of geographical locations in China. They concerned mainly motivation-oriented exploration and effects to local economy, therefore more concentrated on local economy or local market dimensions (Head et al. 2005).

168.3 Research Framework

This paper provides a research framework together with a comprehensive concept to be used in this study, the FDI-based innovation activities.

Without being specifically explained, FDI-based innovation activities as a common term can be used by both capital suppliers (from FDI home country) and capital users (in FDI host region or country). However, there may be differences in the term between these two groups. This paper uses the concept only for evaluation purposes from FDI users' point of view, since the innovation contents is not necessarily the important issue for describing strategic-oriented behavior by capital suppliers. On the contrary, the capital suppliers may prefer to use different definition for such concept as FDI-based innovation activities, normally emphasizing investment returns. Only on long-term commitment basis, the innovation issue can be commonly agreed as important contents for both suppliers and users to apply to so call FDI-based innovation activities (Lucas 2000).

FDI-based innovation activities concept in this paper is designed to cover three groups of innovation related indicators and FDI related indicators. The first group and the second group are innovation lead, and the third group refers to FDI inputs' volume.

First group: technological input

- Absolute value: input of technology related resources from FDI movement.
- Relative value: importance of local FDI firms' innovation input to local innovation input.

Second group: technological output

- Absolute value: output of related activities from FDI.
- Relative value: importance of local FDI firms' innovation output to local innovation output.

Third group: FDI strength

- FDI volume strength based on corporations.
- FDI volume strength based on changes.

The indicators will be used to evaluate FDI-based innovation activities of different regions in China.

1. Technological innovation capability input indicators for FDI firms
   (a) Numbers of the technological personnel in large and middle corporations
   (b) Rate of technological persons in FDI corporations to other local corporations

(c) Numbers of Research and Development institutions in local large and middle FDI corporations
(d) Large and middle FDI corporations' expenditure of technology import
(e) Technological investment in FDI corporations (shares from FDI corporations)
(f) Rate of technology input expenditure in FDI corporations to other local corporations

2. Technological innovation ability output indicators for FDI corporations

(a) Numbers of new product projects in large and middle FDI corporations
(b) Rate of new product development projects in FDI corporations to other local corporations
(c) Numbers of patent registered in China by local large and middle FDI corporations

3. Local FDI strength

(a) Numbers of local large and middle FDI corporations
(b) Average registered capital per local FDI corporation
(c) Average annual increase of real FDI volume between 2009 and 2011
(d) Average investment volume per project in 2011
(e) Average annual increase of FDI scale between 2009 and 2011.

168.4 Empirical Research on Geographical Distribution of FDI-Based Innovation Issues

Since 1992, FDI in China increased dramatically. According to geographical distribution of capital movement, FDI develops in a rather unbalanced mode (Romer 2001).

This paper uses data of the related publications in China from 2002 to 2011. FDI strength in terms of relative measures on FDI scale is different in the regions. In order to keep the original information of FDI-based innovation activities measures, this paper uses PFA method.

A map of FDI-based innovation issues distribution is provided based on score values of different districts on the first component.

In this map, warm color regions represent higher level of FDI-based innovation activities while colder color regions reflect lower level of FDI-based innovation activities (Fig. 168.1).

In order to examine if there is any connections between FDI movement and local industrial innovation activities, another group of indicators (totally 5 indicators based on 2009 statistical data) are summarized through PFA method. The indicators are similarly defined as those in FDI-based innovation activities, but only on local companies, not FDI firms. There is one FDI indicator in the group in order to

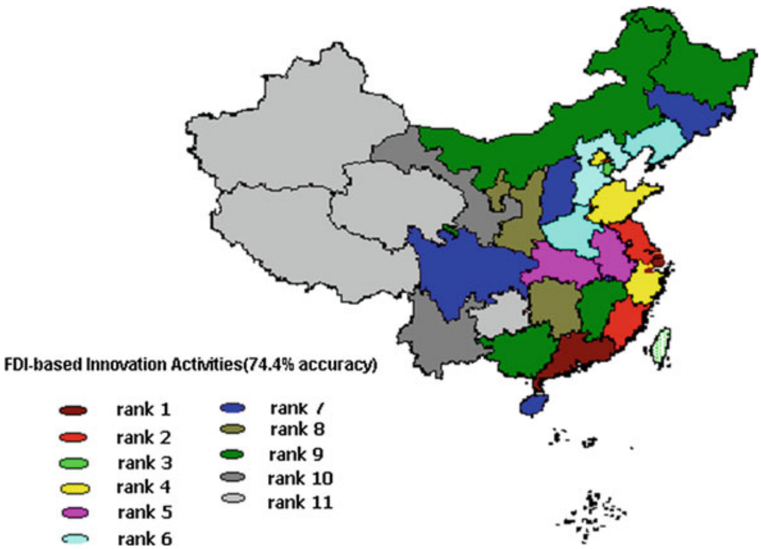

Fig. 168.1 FDI-based innovation activities distribution in different Chinese regions

compare between FDI movement and local industrial innovation activities. Two components are also achieved, which represent 83.2 % of information from original measures.

The coefficient parameters provided in the following can be used again to define the two related components. The first component is highly connected to local industrial innovation level, therefore can be referred as regional industrial innovation level, while the second component is highly connected to average FDI increase, can then be defined as FDI growth level (Table 168.1).

In order to examine the possible connection between FDI movement and local research-based innovation, the third group of innovation related indicators (totally 5 measures are used) is tested to summarize possible relationships with FDI movement through PFA analysis. This time, only one component is achieved

Table 168.1 Correlations between local industrial innovation measures and PFA components

Coefficient loadings	Component	
	1	2
Numbers of local product innovation in large and medium companies	0.955	0.190
Numbers of registered patent by local enterprises	0.937	
Local technological personnel	0.903	0.197
Local R&D Input	0.857	
Local expenditure of technology import	0.785	
Local annual average FDI increase (2007–2011)		0.993

Extraction method: principal component analysis, co-relations on each of the two component, if less than 0.100 in absolute value, are deleted. Rotation method: Varimax with Kaiser normalization

Table 168.2 Correlation parameters between research-based innovation indicators and PFA component

Research-based innovation measures	Component
	1
R&D expenditure in local universities	0.941
Numbers of registered patents: invention patent	0.880
R&D expenditure scales in local universities (average volume per R&D project)	0.860
Scale of contracted research fund for local industries in local universities	0.696
Numbers of contracts in local technology trade market	0.687

Extraction method: principal component analysis

based on the similar calculation condition. It should be noted that in order to separate basic research factors (which is apparently far less relevant to technology innovations concerns), this paper already purposely delete those indicators on more natural science based research measures, and select those indicators more toward industry-related research activities, such as contracted research project for industry, etc., therefore, this group of measures can be used as reference for examination of innovation related research activities.

Table 168.2 show correlation parameters between those research-based indicators the relative distance between original indicators and the component achieved.

168.5 Conclusion

On the basis of the conceptual work and an empirical study on Chinese geographical distribution of FDI-based innovation activities and regional innovation related activities, the results are that FDI-based innovation activities is concentrated in higher FDI volume regions. However, FDI-based innovation activities may not be related to FDI scales, especially in low FDI volume regions. Also, there is rather sharp contrast between coastline regions and inner land districts, according to FDI-based innovation activities. Shanghai city district and Guang Dong province proved to be most important regions in terms of FDI based innovation, and this differentiated FDI-based innovation activities seems to strongly connect to local industrial innovation capability in the region.

However, there are many exceptions on this positive relationship. Regional industrial innovation can be more independent from FDI-based Innovation Activities influences, when there is strong local innovation capability and comparatively less FDI inflows. Connections between FDI-based innovation activities and local innovation activities can be even weak if more research based innovation is involved.

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Chapter 169
Innovative Roles of Brand Community Members: A Typology Based on Cluster Analysis

Xiao-chuan Wang

Abstract This research applied Ward's method to cluster analyze 319 samples collected from online brand community of Apple. Two variables, brand identification and community identification are used to categorize the samples into 4 clusters. Average scores of 15 innovative activities of each cluster are analyzed and thus find the different innovative roles played by brand community members: outside learners, pragmatic explorers, silent devotees and opinion leaders.

Keywords Brand identification · Cluster analysis · Community identification · Innovative roles · Online brand community · Typology

169.1 Introduction

The phenomenon that customers invent or improve a product for their own consuming is not a new fad just after Web 2.0 appeared. In more than three decades, many scholars had explored it and named it different way.

Toffler (1980) defined prosumers as people who produce some of the goods and services entering their own consumption, for example, repairing their cars themselves or designing customized clothes.

Toffler's prosumer thesis was extended by Kotler in 1986 to the context of marketing, stressing individuation, skill-building, and productiveness as relevant marketing themes. Kotler (1986) concluded already in the pre-new media age that

X. Wang (✉)
School of Management, Huazhong University of Science and Technology, Wuhan, People's Republic of China
e-mail: wangxc01@163.com

X. Wang
School of Economics and Management, China University of Geosciences, Wuhan, People's Republic of China

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marketers should look for opportunities to facilitate prosumption activities by creating tools for prosumers to use.

von Hippel (1976) first reported that the central role of innovators can also be users' in the 1970s. He defined users as individual consumers or firms that expect to benefit from using a product or a service, while manufacturers often expect to benefit from selling a product or service to their customers. von Hippel (2005) noticed the trend of open innovation and distributed innovation, and then introduced the concept of "User Centered Innovation".

Customers' wants and their acquired knowledge through the actual use of products make them an essential external resource for innovation (Füller 2006). Some customers are not only knowledgeable but also able to develop their own new products (Prahalad and Ramaswamy 2000). Such innovative customers can be found in online communities. Members of communities of consumption seem to be particularly suitable for the virtual participation in new product development because of their high product interest and knowledge as well as presence on the internet (Füller 2006).

While the role of innovative users in online communities has enjoyed significant development in the literatures, a number of gaps remain (Marchi et al. 2011). Although some authors have used brand communities as virtual settings for their studies, few authors have explored the user innovation in online ''brand'' communities as specific contexts, with unique characteristics different both from offline settings and from not-brand-related online communities.

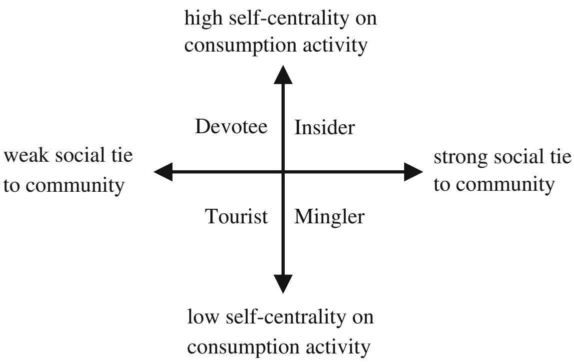
Brand community attracts people who uses or admires the brand. They vary in their acceptance to the brand, and their commitment to the community. Schau and Muniz (2002) categorized community members into four groups with two dimensions: self-identity and community identity. But their research didn't link the membership with the innovative roles.

This paper focuses on the innovative roles of brand community members who differ in identification level of brand and of community, trying to find the relationship among brand identification, community identification and innovative activities members would like to undertake. The result will help companies to understand and utilize customer initiated innovations better.

169.2 Literature

Kozinets (1999) used two factors, relations with the consumption activity, and relations with the virtual community to divided online community members into four distinct types. Here, the relationship with the consumption activity means how central the consumption activity is to a person's psychological self-concept, i.e. the importance of the symbols of this particular form of consumption are to the person's self-image. The second factor is the intensity of the social relationships the person possesses with other members of the virtual community. The two factors will often be interrelated.

Fig. 169.1 Box model of community member types by Kozinets (1999)



The first of the four types are the tourists who lack strong social ties to the group, and maintain only a superficial or passing interest in the consumption activity. Next are the minglers who maintain strong social ties, but who are only perfunctorily interested in the central consumption activity (Kozinets et al. 2008). Devotees are opposite to this: they maintain a strong interest in and enthusiasm for the consumption activity, but have few social attachments to the group. Finally, *insiders* are those who have strong social ties and strong personal ties to the consumption activity (Fig. 169.1).

Schau and Muniz studied the typology of members in brand community. Brand community is "a specialized, non-geographically bound community, based on a structured set of social relations among admirers of a brand" (Muniz and O'Guinn 2001). They categorized community members into four groups with two dimensions: community identity and self-identity (Schau and Muniz 2002). On the community side, the authors focused on three main markers of community. First, they coded evidence of consciousness of kind. Second, the authors noted evidence of the rituals, traditions and history that serve to perpetuate the community's culture and consciousness. Finally, the authors catalogued evidence of community responsibility or duty.

The authors coded on eight dimensions of individual identity. First, they coded for references to the web author's organic self. Second, the researchers noted references to real life (RL) professional activity. Third, they catalogued web content pertaining to RL social affiliations. Fourth, the researchers traced RL brand references or web content that demonstrated brands in relationship to the web author's organic self. Fifth, researchers coded the inclusion of virtual or electronic identities by the web author. Lastly, the researchers noted all references to the web authors' virtual brand relationships, or those brand associations that did not necessarily rely on RL product use or ownership (Meyer et al. 2006) (Fig. 169.2).

The above two researches are the most frequently quoted ones when referring to categorizing of virtual community members. But none of them have related the typology with innovative activities in brand community.

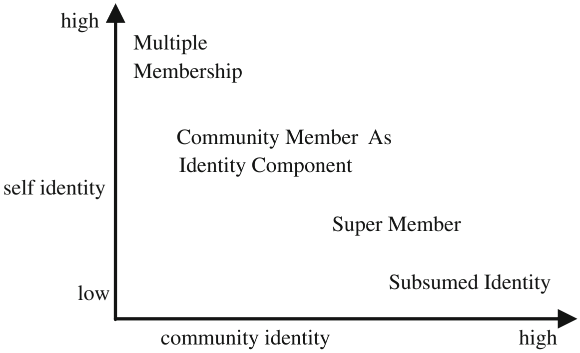


Fig. 169.2 Crosswise model of community member types by Schau and Muniz (2002)

169.3 Methodology

This research follows the above two research to use identity as the major factor to group brand community members. The difference is one of the factor used is identification of brand, and the other is the identification with community.

169.3.1 Measurements of Brand Identification and Community Identification

Specifically, brand identification consists of a self-brand connection component, to reflect the process of social classification and affiliation; a brand salience component, to capture of the importance of the brand to one's self-identity and finally, a brand signaling component, to reflect the utility of the brand in signaling one's self-identity to others (Tildesley and Coote 2008).

A six items scale (Jin 2006) is used in this research to measure the brand identification (Table 169.1).

The author uses the scale of organizational identity developed by Gautam et al. (2004) to measure community identity with some adaption in accordance to the specific context of online community (Table 169.2).

Table 169.1 Measurements for brand identification

No	Scale items
1	The brand image is identical with my personality
2	The brand image is identical with my values
3	The brand image is identical with my taste
4	The brand image is identical with my living style
5	The brand image is identical with my social class
6	The brand helps to distinguish me from those who are not the same kind of person

Table 169.2 Measurements for community identification

No	Scale items
1	I take myself as a member of ※ community
2	I have a lot in common with others in ※ community
3	I visit ※ community much more frequently than other communities
4	I would stay in ※ community
5	I am proud to be a member of ※ community
6	I am glad I chose ※ community rather than another one
7	I have warm feelings toward ※ community
8	I will be angry when I hear people criticize ※ community

169.3.2 Scales of Innovative Activities in Brand Community

The scale of innovative activities is developed on grounded analysis to an online brand community called MacIdea, a virtual meeting place for Apple users and admirers. 4,400 plus postings are screened and coded. Finally, a 15-item-scale is decided (Table 169.3).

169.3.3 Data Collecting and Analysis

A 5-piont Likert scale is used to score the variables. The data was collected from online Apple brand community by a professional online survey websites, sojump.com. Finally 319 complete and qualified samples were received.

Table 169.3 Measuremens for brand community innovation

No	Scale items
1	I skim over the stories and experiences shared by others
2	I am interested in the postings with original stuff
3	I will respond to a survey if I know about that
4	I will rate if I am invited
5	I will write down my experience and discontents and post them in forum
6	I will initiate discussions about my new ideas
7	I used to reply and comment after reading postings by others
8	I will release my innovation in community
9	I will share the source code of my innovation with members in community
10	If I learned or tried others innovation, I will give feedback comments
11	I will invite others to give suggestions to improve my innovation
12	I would like to participate in pilot testing
13	I will post for help in community
14	I am very glad to help others with my own experience and knowledge
15	I always choose more private methods such as PM, email and so on to communicate with others about what I am interested in

The author uses brand identification and community identification as two variables to do cluster analysis. Ward's method is applied with setting 4-cluster-solution as final objective in advance. After the members of 4 clusters are determined by SSPS 19.0, the average scores of every activity are calculated for each cluster.

169.4 Findings

The 319 sample is categorized into 4 clusters as required and is named as "A", "B", "C", and "D". Compared with the average scores of brand identification and community identification in each cluster, it is obvious that these two variables have a positive correlation. With the increase of brand identification of brand community members, the score of community identification increase simultaneously and vice versa. See Tables 169.4 and 169.5.

Innovative activities are also positive correlative with brand identification and community identification. In other words, the higher the identification degree, the higher likelihood of participation in community innovative activities. Rank the scores of 15 innovative activities for each cluster, we will find that 4 clusters have some habits in common (Table 169.6).

To "skim over the stories and experiences shared by others" is the fundamental work for every cluster except cluster B. The same thing happens to "interest in original stuff". And of course each group has its special interest.

Cluster A got the lowest score in both brand identification and community identification. Compared with the other 3 clusters, the sense of identity to the community in Cluster A are much lower than identity to brand. The members

Table 169.4 Average scores of six items of brand identification

Cluster	N	1	2	3	4	5	6
A	54	3.41	3.537	3.72	3.31	2.72	2.264
B	121	3.81	3.62	3.812	3.75	3.917	3.43
C	102	4.53	4.44	4.588	4.38	4.157	3.743
D	42	4.76	4.9	4.952	4.88	4.905	4.476

Table 169.5 Average scores of eight items of community identification

Cluster	N	1	2	3	4	5	6	7	8
a	54	3.17	3	2.81	2.96	2.85	2.68	2.85	2.57
b	121	3.71	3.56	3.51	3.73	3.67	3.51	3.72	3.44
c	102	4.36	4.40	4.38	4.24	4.18	4.26	4.28	4.02
d	42	4.97	4.78	4.64	4.83	4.90	4.54	4.88	4.69

Table 169.6 Top 3 preferred activities in each cluster

Cluster	Score	Activities most likely to do
A	3.796	I skim over the stories and experiences shared by others
	3.788	I am interested in the postings with original stuff
	3.611	I will respond to a survey if I know about that
B	3.851	I will respond to a survey if I know about that
	3.818	I will post for help in community*
	3.818	I skim over the stories and experiences shared by others
C	4.392	I am interested in the postings with original stuff
	4.373	I will respond to a survey if I know about that
	4.304	I would like to take pilot testing*
D	4.81	I am interested in the postings with original stuff
	4.784	I skim over the stories and experiences shared by others
	4.784	I am very glad to help others with my own experience and knowledge*

* means the top preferred activity in each cluster

prefer to browse and click without posting. Data from Table 169.7 show that Cluster A members is more likely to adopt non-public ways to communicate. They can be named as "outside learners".

Cluster B members are much more animated than cluster A though they are not as loyal to brand and community as members of Cluster C and D. They would like to seek for help and also be glad to help others. They are eager to find and doubt new things in the community. They are pragmatic explorers in the community.

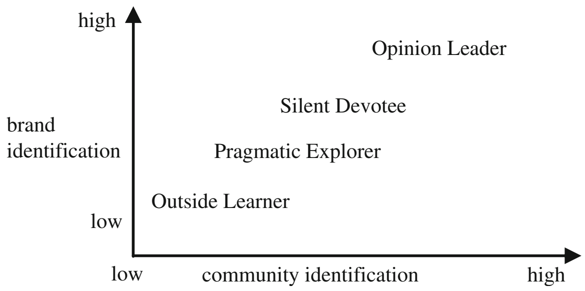
Cluster C members seem a little strange because they are quite loyal to both the brand and the community and have much higher willingness of community commitment than the former two groups. But surprisingly, data show Cluster C members are more passive than Cluster B fellows. They behave in the way similar to Cluster A but with much higher devoting desires. Among the top three preferences, they are more likely to taking pilot testing than other members. Cluster C members are silent devotees in brand community.

Cluster D members have the highest score in all three dimensions. They intensely attach themselves with the brand and community socially and emotionally. Of all the 29 scores in 3 dimensions, the lowest score of Cluster D (4.048) is greater than the highest score of Cluster A and B (3.851). Besides browsing the new postings in the forum, the best thing they want to do is to help others. Cluster D members are the most sophisticated and vocal users in the community, they are true opinion leaders.

Table 169.7 Average scores of fifteen items of brand community innovative activities participation

Cluster	N	Innovative activity scale items														
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
A	54	3.796	3.778	3.611	3.259	2.796	2.556	2.926	2.570	2.519	3.093	2.722	3.444	3.444	3.370	3.000
B	121	3.810	3.802	3.851	3.678	3.455	3.430	3.537	3.397	3.281	3.463	3.372	3.736	3.818	3.785	3.479
C	102	4.235	4.392	4.373	4.284	3.951	4.059	4.039	3.961	3.667	3.992	4.059	4.304	4.049	4.206	3.902
D	42	4.786	4.810	4.714	4.524	4.619	4.524	4.619	4.500	4.381	4.548	4.476	4.714	4.595	4.786	4.048

Fig. 169.3 Innovative roles of four types of brand community members



169.5 Conclusions

The cluster analysis to 319 samples from online brand community of Apple clearly proved that:

Brand identification, community identification and community activity involvement are high positive correlative. A community member with higher identity degree with specific brand, the higher community identification and greater commitment to the community could be claimed.

The members could be categorized into four clusters by brand identification and community identification. Each cluster is supposed to play different innovative roles.

The four clusters are shown in Fig. 169.3.

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Chapter 170
Organizational Innovative Climate, Innovative Behavior and the Mediating Role of Psychological Capital: The Case of Creative Talents

Li-wei He

Abstract The 21st century witnesses the boom of creative industry, whose core competence lies in creative talents. In China this industry is in its preliminary stage with scant cultivation and support for the creative talents, which is detrimental to creative idea generation and implementation. From the perspective of organizational innovative climate in the creative industry, this study explored its impact on creative talents' innovative behavior, and the mediating role played by creative talents' psychological capital. After analyzing the first-hand data got from 32 companies in Hangzhou's creative parks, the results showed employees' perceived organizational innovative climate had a significantly positive impact on their innovative behavior, and their psychological capital partially mediated this relationship.

Keywords Creative industry · Individual innovative behavior · Organizational innovative climate · Psychological capital

170.1 Introduction

Creative industry is the sum of activities with cultural connotations which are derived from human creativity and wisdom, and which can be commercialized with technology support and market operation (Zhang 2006). Creative talents are the core resource of creative industry. China's creative industry is still in its infancy, lacking in originality and talents, and the shortage of top creative talents has become the bottleneck restricting the development of the industry (Yuan and Zhang 2009). One important reason is the weak supporting platform; that is, the

L. He (✉)
School of Management, Zhejiang University, Hangzhou, People's Republic of China
e-mail: verahepanpan@zju.edu.cn

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organizational climate for innovation in this industry is not strong enough, and it severely constrains creativity and innovation to emerge and to be implemented. Take animation industry as an example, willingness of quick success and instant benefits, and processing workshop operation mode, greatly limit the cartoonists' creativity and prevent the emergence of top creative talents (Li 2006). Too much intervention from executives, distrust in talents' creativity, and lack of spirit of adventure, lead to good ideas on the shelf. Thus, it's important to explore how organizational innovative climate impact on creative talents' innovative behavior in China's creative industry.

Individual innovative behavior can be regarded as a kind of working method, which generates novel while appropriate ideas, process, and solutions (Amabile 1983), and it includes five dimensions: opportunity exploration, generatively, formative investigation, championing, and application (Kleysen and Street 2001).

Amabile et al. (1996) thought of individual/team-level creativity as the starting point of innovation, but they stressed that successful innovation also relied on other factors, such as organizational innovative climate. Organizational innovative climate is organizational members' perception of support for creativity and innovation from work environment. It includes five factors: encouragement of creativity, autonomy or freedom, resources, pressures, and organizational impediments to creativity (Amabile et al. 1996). The stronger the organizational innovative climate, the more actively employees will exert innovative behavior (Tsai and Kao 2004). More specifically, team leader's working style and efficacy significantly influence members' creativity and innovation (Oldham and Cummings 1996; Amabile and Conti 1999) organizational support and work environment autonomy positively affect innovative idea implementation, and together with teamwork, they exert positive impact on innovative idea generation (Huang 2006). Thus, this study proposed the following hypothesis to test its applicability in creative industry:

H1 organizational innovative climate has a positive impact on individual innovative behavior

Tentative results showed organizational innovative climate didn't directly influence creative talents' innovative behavior, but through the impact on talents' state of mid like self-efficacy (Huang 2006; Luthans et al. 2008a). Tsai (2000) studied private businesses in Taiwan, and found that organizational system and institution, company-employee relationship, and work requirement were positively related with employees' self-efficacy. Huang (2006), (2003) respectively researched into R&D team and banking industry, and found self-efficacy positively influenced individual innovative behavior.

According to Luthans, self-efficacy is one dimension of psychological capital. Psychological capital is the core factor of individual general positive psychology, and is a psychological state which accords with positive organizational behavior standard, and which can help individuals gain competitive advantages after targeted investment and development, transcending human capital and social capital

(Luthans et al. 2005). Psychological capital consists of four aspects: self-efficacy, hope, optimism, and resilience. Specifically, a person with positive psychological capital (1) has confidence (self-efficacy) and spares no effort to be successful in the face of challenging work, (2) does positive attribution regarding present and future success (optimism), (3) is perseverant, and will adjust the ways to success when necessary (hope), (4) is persistent, and can bounce back quickly (resilience) to achieve success when confronted with problems and adversity (Luthans et al. 2008).

Luthans et al. (2008) studied an insurance company and a high-tech manufacturing enterprise, and found supportive organizational climate could enhance employees' work satisfaction and organizational commitment, while psychological capital played a mediating role. Their results also showed employees who perceived stronger organizational supportive climate exerted higher level of psychological capital Luthans et al. (2008).

Some empirical researches have shown the positive relationship between psychological capital and performance, satisfaction, organizational citizenship behavior, and organizational commitment, such as Luthans et al. (2005), Zhong (2007), both in China context. If we treat innovative behavior as a component of work performance, then we can assume that psychological capital has a positive impact on individual innovative behavior, to be tested empirically.

From traits perspective, Jin (1998) thought creative individuals' personalities include: self-control, autonomy, independence, impulsiveness, curiosity, flexibility and durability. The former three personalities are similar in connotation to self-efficacy and optimism, while curiosity and flexibility have close meaning to hope, and durability can be regarded as the synonym of the resilience. Feng (2005) found the widely-recognized psychological structure of innovative talents was composed of five dimensions: creative thinking, willpower, ability, knowledge and sense. Among them, ability and willpower have quite similar meaning to self-efficacy and resilience in the construct of psychological capital.

Based on above theoretical background, this study proposed the following hypotheses:

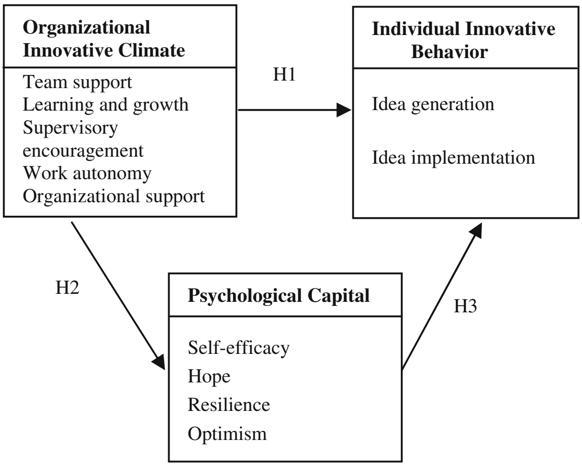
H1 Organizational innovative climate has a positive impact on individuals' psychological capital

H2 Individuals' psychological capital positively influences their innovative behavior

H3 Psychological capital mediates the relationship between organizational innovative climate and individuals' innovative behavior

The theoretical model is showed in Fig. 170.1.

Fig. 170.1 Research model



170.2 Methodology

170.2.1 Method

The researcher went to creative industry parks in Hangzhou, like LOFT 49, A8, and Digital Entertainment Industry Park, and selected creative talents in planning, design, photography, writing, and other aspects, and carried on questionnaire survey, accompanied by some open-ended interviews with managers and designers.

The study sent 296 pieces of questionnaire in total, and retrieved 235 pieces, and among them 209 pieces were effective (effective retrieving rate was 70.13 %). Effective data sampled from 32 companies.

170.2.2 Measure

The questionnaire included five parts: preface, individual innovative behavior measure, psychological capital measure, organizational innovative climate measure and demographic information. Likert scale was applied to the questionnaire, with 1 representing totally disagree, and 6 meaning totally agree.

Individual Innovative Behavior Measure: The five-dimension innovative behavior theory proposed by Kleysen and Street (2001) lacks good construct validity. Huang refined the scale by applying it to research in Taiwan and found individual innovative behavior was composed of two dimensions: idea generation and idea implementation. This finding was consistent with West (2002), who divided innovation into two phases: idea generation (creativity) and idea implementation (putting new or improved product or service into workplace.

Based on Huang's scale, this study worked out the scale after expert interviews. Exploratory factor analysis (EFA) showed that individual innovative behavior included two factors: idea generation (opportunity exploration and generatively), and idea implementation (formative investigation, championing, and application). Accumulative total variance explained percentage was 57.562 %, and internal consistency coefficient (ICC) was 0.809, showing good reliability.

Psychological Capital Measure: The Psychological Capital Questionnaire developed by Luthans et al. (2008a, b) was applied in this study. Four dimensions: self-efficacy, hope, resilience and optimism, all were measured by 6 items. ICC was 0.822.

Organizational Innovative Climate Measure: Amabile, Conti, Coon, Lazenby, and Herron (1996) based their measure on employees' subjective perception, and they insisted that organizational innovative climate measure should consider the whole organizational level, managerial control characteristics, and team operation. They developed KEYS scale to measure employees' perception of the innovative climate, which consisted of eight dimensions: organizational encouragement, supervisory encouragement, work group supports, freedom, sufficient resources, challenging work, workload pressure, and organizational impediments (Amabile et al. 1996).

Qiu consummated the scale in China context, resulting in sound ICC, and Huang also used his scale. So it was applied in this study. EFA showed organizational innovative climate consisted of four dimensions: team support, supervisory encouragement, learning & growth, work autonomy, and organizational support. Accumulative total variance explained percentage was 73.956 %, and internal ICC was 0.921.

170.3 Results

170.3.1 Descriptive Statistics and Correlation Analysis

Using SPSS 16.0, results showed the organizational innovative climate in Hangzhou's creative parks was good on the whole, and the employees had high level of psychological capital, and behaved innovatively.

In terms of organizational innovative climate, the creative enterprises provided enough team support and supervisory encouragement (avg. = 4.897, 4.796; SD = 0.789, 0.933), while relatively less in learning & growth and work autonomy, with a big gap among individuals' perception (avg. = 4.254, 4.211; SD = 1.177, 1.115). In terms of psychological capital, creative talents showed high level of self-efficacy, and slightly high level of hope; the levels of resilience and optimism were relatively lower, yet still belonging to high levels. Their innovative behavior was in sound level, with no big difference between idea generation and idea implementation.

Correlation analysis showed significant correlation among the constructs and their main dimensions, except that self-efficacy was not significantly related to learning and growth and work autonomy. The results laid solid foundation for regression analysis.

170.3.2 Regression Analysis

This study used hierarchical regression to test the hypotheses, according to Baron and Kenny (1986). As shown in Tables 170.1, 170.2 and 170.3, the results indicated:

1. Organizational innovative climate had a significant impact on individual innovative behavior ($\beta = 0.367$, $\triangle R^2 = 0.208$, $p < 0.001$), and it positively affected idea generation ($\beta = 0.407$, $\triangle R^2 = 0.193$, $p < 0.001$) and idea implementation ($\beta = 0.327$, $\triangle R^2 = 0.133$, $p < 0.001$). H1 got verified.
2. Organizational innovative climate had a significant impact on psychological capital ($\beta = 0.329$, $\triangle R^2 = 0.270$, $p < 0.001$). H2 was verified.
3. Psychological capital positively influenced employees' innovative behavior ($\beta = 0.799$, $\triangle R^2 = 0.360$, $p < 0.001$). H3 was verified.
4. Psychological capital partially mediated the influence of organizational innovative climate on individual innovative behavior ($p = 0.000$ turned to $p = 0.021$, $\triangle R^2 = 0.175$) and on idea generation ($p = 0.000$ turned to

Table 170.1 Regression analysis to test H1

	Individual innovative behavior		
	Model 1	Model 2	Model 3
Gender	−0.155	−0.163	−0.096
Age	0.170	0.142	0.079
Education	−0.187	−0.161	−0.109
Co. Size[a]	0.069	0.006	−0.039
Org. IC[b]		**0.367*** **	**0.147** **
PsyCap[c]			**0.666*** **
R^2	0.086	0.294	0.469
Adj. R^2	0.057	0.266	0.443
F	2.957	10.326***	18.129***
$\triangle R^2$	0.086	0.208	0.175

Note 1 (a) Co.Size = company size, (b) Org. IC = organizational innovative climate, (c) Psy-Cap = psychological capital
Note 2 *** $p < 0.001$; **$p < 0.05$
Note 3 * represent statistical significance at the 10 %
Note 4 ** represent statistical significance at the 5 %
Note 5 *** represent statistical significance at the 1 %

Table 170.2 Regression analysis to Test H2 and H3

	Psy Cap		Individual IB[d]	
	Model 1	Model 2	Model 1	Model 2
Gender	−0.094	−0.101	−0.155	−0.080
Age	0.120	0.095	0.170	0.074
Education	−0.101	−0.078	−0.187	−0.106
Co. Size	0.124**	0.068	0.069	−0.030
Org. IC		**0.329*** **		
PsyCap				**0.799*** **
R^2	0.093	0.363	0.086	0.446
Adj. R^2	0.064	0.337	0.057	0.423
F	3.213	14.119***	2.957	19.942***
$\triangle R^2$	0.093	0.270	0.086	0.360

Note 1 (d) Individual IB = individual innovative behavior
Note 2 **$p < 0.005$
Note 3 * represent statistical significance at the 10 %
Note 4 ** represent statistical significance at the 5 %
Note 5 *** represent statistical significance at the 1 %

Table 170.3 Regression analysis to test H4

	Idea generation			Idea implementation		
	M[e] 1	M 2	M 3	M 1	M 2	M 3
Gender	−0.200	−0.210	−0.151	−0.109	−0.117	−0.040
Age	0.261	0.230	0.175	0.078	0.054	−0.018
Education	−0.157	−0.129	−0.083	−0.217	−194	−0.135
Co. Size	0.145	0.075	0.036	−0.007	−0.063	−0.114
Org. IC		**0.407*** **	**0.216***		**0.327*** **	**0.079**
PsyCap			**0.579*** **			**0.753*** **
R^2	0.107	0.300	0.400	0.053	0.186	0.368
Adj. R^2	0.079	0.272	0.371	0.023	0.154	0.337
F	3.749	10.627***	13.672***	1.764	5.684***	11.912***
$\triangle R^2$	0.107	0.193	0.100	0.053	0.133	0.181

Note 1: (e) M = model
Note 2 * $p < 0.01$
Note 3 * represent statistical significance at the 10 %
Note 4 ** represent statistical significance at the 5 %
Note 5 *** represent statistical significance at the 1 %

$p = 0.006$, $\triangle R^2 = 0.100$), and fully mediated the relationship between organizational innovative climate and idea implementation ($p = 0.000$ turned to $p = 0.306$, $\triangle R^2 = 0.181$). H4 was partially verified.
5. Considering the five dimensions of organizational innovative climate, supervisory encouragement and work autonomy had a positive impact on idea generation and innovative behavior on the whole, while team support and organizational support mainly influenced idea implementation. And psychological capital mediated the relationship to different degree.

170.4 Discussion

This study showed organizational innovative climate had a positive impact on creative talents' innovative behavior, and the innovative climate on the whole exerted more influence on innovative behavior than the sum of its dimensions. This may indicate that there exists synergy among the five dimensions of organizational innovative climate. So, creative companies should pay attention to create the whole innovative climate, especially in learning and growth and work autonomy, in which there is much room for improvement.

Organizational innovative climate influenced more on idea generation ($\beta = 0.407$, $\triangle R2 = 0.193$, $p < 0.001$) than on idea implementation ($\beta = 0.327$, $\triangle R^2 = 0.133$, $p < 0.001$). This is consistent with Huang's (2006) finding, indicating that a sound innovative climate can greatly stimulate creative talents to generate ideas, providing solution for originality shortage. When it comes to dimensional level, supervisory encouragement and work autonomy significantly affect idea generation, while team support and organizational support influence more significantly on idea implementation. Thus, in different phases of innovation, companies should adjust the focus of climate creation and resource allocation.

This study found psychological capital partially mediated the relationship between organizational innovative climate and individual innovative behavior, and fully mediated innovative climate's impact on idea implementation. Therefore, it's a must to develop and enhance creative talents' psychological capital in order to facilitate their innovative behavior. Companies can turn to the Psychological Capital Intervention Model proposed by Luthans et al. (2008a, b): developing hope by goal and approach design and barrier plan implementation; nurturing realistic optimism by building self-efficacy/confidence and positive expectation; developing self-efficacy/confidence via experiencing success and imitating others, as well as persuasion and awakening; intervening resilience through achieving resources and hazards avoidance, and changing affecting process.

In addition, it's worth noting that learning and growth didn't significantly impact on innovative behavior, based on this study's sample. This surprising result may be caused by the fact that creative industry is in its infancy in China, and there lacks effective professional training programs for creative talents. Interviews with managers and employees revealed that most of Hangzhou's creative companies were small and medium enterprises, so they lacked systematic human resource management: mainly relying on poaching talents from competitors, and rarely on training their own creative talents. Such fact leads to the whole industry paying not enough attention to organizational learning, thus no significant impact on innovative behavior.

170.5 Conclusion

Most literature on creative industry appeared in recent 20–30 years, and they mainly focused on American enterprises, aiming at macro industrial level. So there lacks in-depth research from the perceptive of creative talents, who generate and implement the ideas. In China, creative industry is in its infant stage, and particularly there lacks research into creative talents' innovative behavior. Starting from the psychological capital perspective, this study explored the influence of perceived organizational innovative climate on individual innovative behavior, and constructed a systematic model. This is of pioneering value.

However, this study still has some limitations. Self-report method may result in common method bias. The psychological capital questionnaire was developed in American context, so cultural difference may influence data quality. Besides, there lacks mature scale for measuring individual innovative behavior, and this may affect questionnaire reliability and validity, as well as results generalization. Therefore, it's of great value to develop and refine scales in China context, to search for more effective solutions for building excellent organizational innovative climate with the theory and framework proposed by Amabile and other scholars, and to take further research into the intervention of psychological capital.

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Chapter 171
Research on Collaborative Innovation Mechanism of SMEs

Qiu-ming Yang

Abstract As dynamic and main force of domestic market, small and medium-sized enterprises keep stimulating the development of economy. As a result, the quality and level of growth of SMEs determine the overall development of national economy. The innovation capability guarantees core competence of enterprise and is an important basis of upgrading national competitiveness. Based on the theory of collaborative innovation, this article explores establishing co-innovation of small and medium-sized enterprises, so as to bring up its innovation capability, and will contribute to a rapid and sound development of national economy.

Keywords Collaborative innovation · Innovation capability · SME · Technological innovation

171.1 Introduction

With economy changing dramatically, innovation is becoming more and more important and competition between companies is actually relying on their innovative power. The most challenges that small and medium-sized enterprises are facing are how to make new breakthrough to promote the innovation power (Genhong 2007). With the advent of knowledge economy, the life cycle of product and technology is being shortened. It's more and more difficult for companies to innovate independently via introducing technologies to make the companies adaptable to the increasingly fierce competitive environment (Xie 2010). Therefore, the survival and growth of small and medium-sized enterprises is subject to

Q. Yang (✉)
Economic and Financial Department, Suqian College, Suqian, Jiangsu, China
e-mail: qmyang@126.com

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interaction of various factors and groups to develop jointly in order to innovate collaboratively and completely.

171.2 Problems with Innovation of SMEs

Most small and medium-sized enterprises in China grow out of market shortage and are less competitive and find it hard to keep foothold in the market. With economic environment changing enormously, companies have to innovate in order to survive and grow. However, many small and medium-sized enterprises in China have a great many problems with innovation.

171.2.1 Creative Factors are Pale

Whether a company needs or is capable of innovation is closely related not only to its self-strengths but also to its innovation consciousness and ideology (Hewitt-Dundas 2006). Most small and medium-sized enterprises in China are now realizing the significance of innovation but concentrate more on respective innovation of technology, product and market or structural reform, thus yielding low success rate.

171.2.2 Lack of Outer Information Resource

Outer information resources are significant foundation for companies to be acquainted with new technologies and market opportunities (Massa and Testa 2008). Given that most small and medium-sized enterprises in China have limited commercial activities, low quality of personnel and management, and inadequate marketing development and research, etc., SMEs are lagging behind at gathering outer information resources that SMEs are also not capable of selecting and recognizing, thus causing the collected information less accurate (Lv et al. 2011). In addition, enterprises fail to establish an active communication channel with colleges and scientific institutions and just obtain information on their own, resulting in inaccurate acquisition of related industry trends when making decisions and low innovation performance.

171.2.3 Insufficient Government Support

With small and medium-sized enterprises becoming increasingly important in national economy, the development of small and medium-sized enterprises are arousing more attention from the government (Tsai and Wang 2009). However, SMEs are not as well treated as large companies with financing, technology introduction, information and social service, definitely affecting SMEs to be more innovative.

171.3 Establishment of Collaborative Innovation Mechanism of SMEs

With more and more innovative practices of corporations and continuous research on innovation of scholars, innovators are not only creative in technologies (including products or skills) but also be creative through collaboration of various factors and various groups to promote the overall innovation capacity on the basis of national innovation system (Segarra-Blasco and Arauzo Carod 2008) (Fig. 171.1).

171.3.1 Internal Co-innovation

Internal co-innovation is mainly made of different creative factors and various business processes and achieved by their interaction.

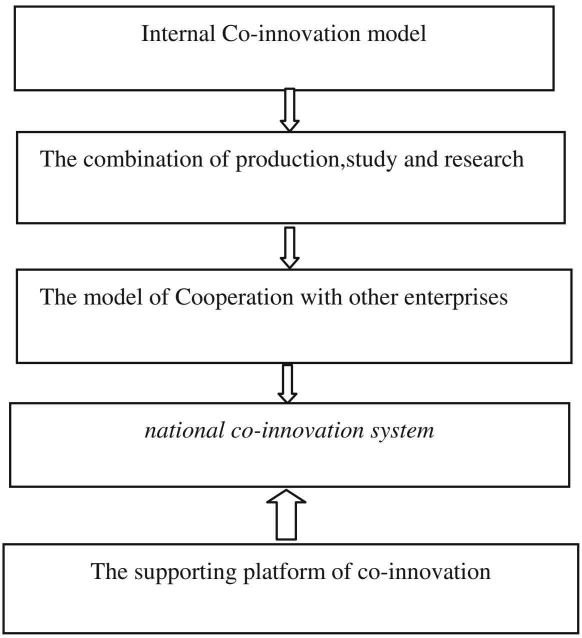


Fig. 171.1 Collaborative innovation mechanism of SMEs

First of all, small and medium-sized enterprises cannot merely concentrate on innovation in technologies or marketing but also need to be aware that the aim of innovation is to raise core competitiveness to accelerate growth of companies instead of just inventiveness (Serrano and Fischer 2007). To make sure sustainable development, enterprises should count on overall co-innovation among technologies, strategies, culture, organization, marketing, system and so on rather than only relying on innovation of single factor such as technological innovation. The synergistic effect, raised by the collaborative work of technology and marketing as key factors and all others, will further promote innovation effectiveness. Concretely speaking, enterprises should integrate technology innovation, marketing innovation, system innovation, culture innovation and organization innovation in the context of strategic innovation, among which technology and marketing change significantly while other elements stay rather stable (Segarra-Blasco and Arauzo Carod 2008). With guidance of technology innovation and marketing innovation and support of other creative factors, small and medium-sized companies will consequently reach thorough internal co-innovation in accordance with strategic innovation (Fig. 171.2).

Secondly, a great mass of small and medium-sized enterprises with inefficient work flows grow slowly in value and should accordingly innovate in business processes and rebuild the entire value chain (Chen and Yang 2012), which specifically

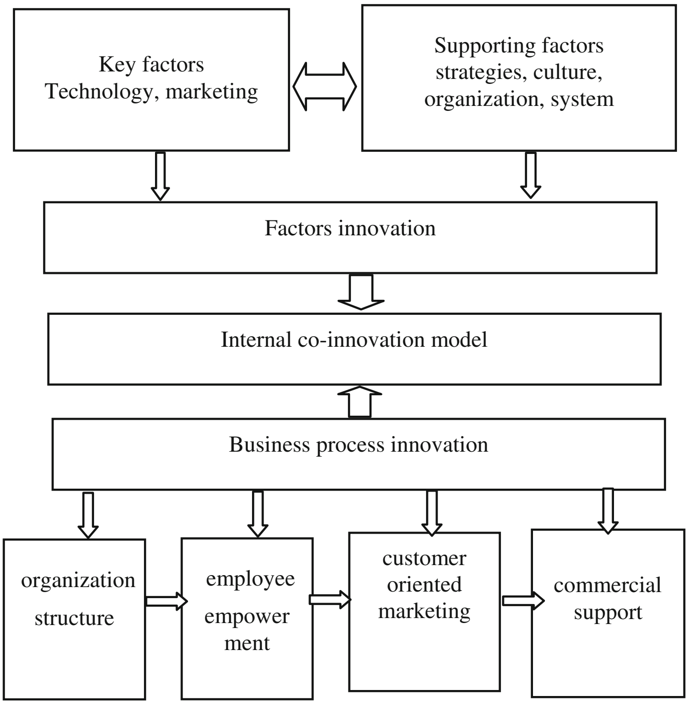


Fig. 171.2 Internal co-innovation model

include: advocating refinement to organization structure, employee empowerment, customer oriented marketing and commercial support as well as establishment of reasonable business processes on long-term development goals and strategies, and also in the center of improvement of value-added workflow to produce corporation value and ultimately to reach the goal of making companies adaptable to intensive competition and economic environment change (Dubberly 2008).

171.3.2 External Co-innovation

Many failures of innovation are caused by neglect of innovative cooperation among small and medium-sized corporations and with other institutions (He 2012). In order to enhance innovative performance and competitiveness, small and medium-sized corporations need to implement external co-innovation from the following aspects.

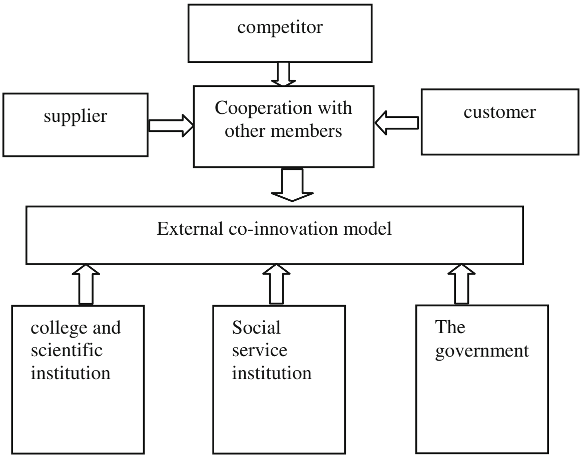
From horizontal point of view, small and medium-sized corporations with strong market development capability can form a powerful alliance of producing and research with colleges and scientific institutions superior in talents, technologies, information etc., in the way of collaborating on technology innovation to forge complementary advantages (Xin and Feng 2011). In particular, entrepreneurs, colleges and scientific institutions can take advantage of their own strengths to share responsibilities generated by resources allocation in different phases on the basis of technology co-operation.

Overall, small and medium-sized corporations cannot just innovate independently but also need to cooperate with other members in the supply chain and to be creative with product design, manufacturing and sales and the whole product's life cycle with suppliers, manufacturers, dealers and customers, in favor of integration of all innovation resources to improve the overall performance of the supply chain (Ou and Liu 2011) (Fig. 171.3).

171.3.3 Foundation of National Co-innovation System

With the trends of economic globalization, the innovation of small and medium-sized corporations relies increasingly on government support and new policies (Zhang and Wang 2011). In order to keep innovative performance, a new national co-innovation corporation-centered system involving entrepreneurs, colleges, scientific institutions, intermediary service organizations and government is needed, in which SMEs will be stimulated by talents, technologies and related information from colleagues and scientific institutions, loans from financial departments, intellectual services such as information consulting services from intermediary service organizations, governmental support or supportive policies in research and development investment, rewards of scientists and technicians, intellectual property rights protection

Fig. 171.3 External co-innovation



and supervision as well as related guidance, encouragement and protection (Feng and Wang 2011). Increased interaction and cooperation between five entities, in compliance with allocation and innovative demands and supplies, establishes a cooperative and creative network and platform and co-innovation in the whole system.

171.4 Conclusion

It is quite common for enterprises to complement each other in market economy. Innovative elements, workflows and entities of innovation system are not isolated but interact interdependently and progress together, which is a dynamic evolution process, fully embodying complementarity and having significant influence on growth of companies. Consequently, cooperative innovation and independent innovation are not mutually exclusive. Cooperative innovation will become major innovative methods of small and medium-sized corporations and independent innovation is not going to be abandoned. Under international cooperative innovation system, small and medium-sized corporations need to achieve firstly the coordination of internal and external factors so as to implement independent and joint innovation and enhance innovative capacity.

In conclusion, it's a systematic project to increase one corporation innovative capacities, which will motivate sustainable development and growth of small and medium-sized corporations, requiring positive involvement of different entities, strong support of the government and continuous improvement.

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Chapter 172
Research on the Relationship Between Enterprise Innovation and the Formation of Core Competitiveness

Zhu Xin

Abstract The goal of this paper is to analyze the content and structure of enterprise innovation, the influence of the innovation to core competitiveness, and the countermeasures for the enhancement of enterprise innovation based on core competitiveness perspective. Firstly, we make an introduction about the definition of innovation, and also make an analysis about the content and structure of innovation. Then, we make a discussion about the relationship between innovation and core competitiveness, and find that the innovation can influence the formation of core competitiveness. Finally, we put forward the strategic routes and corresponding suggestions for the enhancement of innovation to realize their core competitiveness.

Keywords Core competitiveness · Enterprises · Innovation · Influence

172.1 Introduction

Today's era is the era of knowledge economy, knowledge, technologies are changing the rhythm of double speed, companies are ups and downs this change, promotion, lasting and stable development of some companies, there are many enterprises, the leading position three to five years further trouble. The reason lies in whether the enterprise has the adaptability and innovation to transformation strain, innovation and development, innovation is the key to survival and development (Baldwin 1992). Of a business to achieve sustained development must be a full range of innovation, which includes not only technological innovation, thinking, management, marketing and brand innovation, but also institutional and cultural innovation.

Z. Xin (✉)
School of Management, Guangxi University of Technology, Liuzhou, People's Republic of China
e-mail: 5266736@qq.com

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System of innovation is a guarantee of innovation, which enable enterprises to enter a virtuous cycle of innovation track.

Many enterprises in China in its development process, the prevalence of a heavy, light system, the tendency to focus on how to invest more human and material resources to research and development of new technology, how to take a more flexible and more effective way to improve the new technology, and not to make institutional arrangements conducive to innovation and work hard, when the company appeared slow industrialization of scientific and technological achievements, or lack of motivation and other issues of innovation, not from overcoming the system, the defects on the incentive mechanism to solve the problem oriented while attempting to improve the sense of technological innovation, strengthen the technical progress assessment indicators to promote enterprise development, often with little success (Almeida 1996).

172.2 Theoretical Issues Related to Innovation Analysis

Innovation is the enterprise to obtain a source of sustainable competitive edge. J. A. Schumpeter treat innovation as the transfer of invasive species production function, or factors of production and a re-combination of production conditions and production systems to introduce technology system change occurs, for entrepreneur's excess profits or potential profits of the process. Schumpeter summarized the contents of the innovation in five aspects: the production of new products, new technology, opening up new markets, using new materials and new production and management. Involved with the innovation theory as a wide range of content, innovation also has a wealth of meaning (Chaohui 2008). The role of the object from the innovation, technological innovation and institutional innovation is the most important part.

Among them, technological innovation, including the basic theory of innovation, product innovation, process innovation; and institutional innovation can be divided into two levels: (1) macro-economic system of innovation, such as corporate property rights system, monetary policy, industry regulations; (2) micro-organization and management innovations, such as incentive systems, personnel systems, and production organizations. Enterprises, universities, research institutions are considered to be innovative troika, which is profit-oriented enterprise the most important subject of innovation. But this is only for technical innovation in product innovation and process innovation, system innovation and management innovation in terms of the microscopic organization, for the rest of innovation. It is not entirely the case (Carpenter 2003). In general, the basic theory of innovation is more complete by the universities and research institutions, and enterprises to complete the basic theory of innovation is relatively small; and macro institutional innovation are mainly from the government and related organizations to achieve (Jiang 2005; Lazonick 2003).

172.3 The Content and Structure of the Enterprise's Core Competitiveness

172.3.1 The Content of Core Competitiveness

Since the American scholar Prahalad and British scholar Hamel, in the magazine Harvard Business Review published the "company's core competitiveness" in 1990, a paper presented the concept of core competitiveness for the first time, the core competitiveness research, corporate management has become a hotspot. The core competitiveness as the origin of competitive advantage has the following five characteristics:

1. Value. Contribute to the core competitiveness of enterprises in the core values of customer value, unique value to consumers and benefits, which enable enterprises to provide users with the fundamental benefits of skills to be regarded as core competencies.
2. Unique. Core competitiveness is a unique characteristic of the enterprise. It is in the process of enterprise development and the accumulation and long-term birth, conceived in corporate culture, deeply embedded in enterprise quality among the staff of the co-owned.
3. Scalability. Have certain core competitiveness scalability, a variety of products for enterprises to open the market to provide support to a range of products or services on enterprise competitiveness are promoted.
4. Inimitability. The core competitiveness in enterprise production and business activities during the long-term accumulation of form deeply printed on firm-specific component, a special brand of experience, difficult to imitate in other companies.
5. Dynamic. Core competencies are not static, after a certain time, as technology advances and economic development, then later become the core competitiveness of the basic ability or general ability, it is with science and technology, social and economic development was dynamic.

172.3.2 The Structure of Core Competitiveness

On core competencies and characteristics of content analysis, we found that enterprises in the culture, learning ability, creativity have the three aspects of these five characteristics (Jensen 1990). Among them, the corporate culture is the core competitiveness of origin; corporate learning the role of force is the result of corporate culture; enterprise innovation ability of enterprises to further extends the learning ability and sublimation. That is the core competitiveness through corporate culture and corporate culture of learning under the action of force and innovative combination of the three shown (Chang 2000). Within the core competitiveness, and cultural force in the center, learning ability, innovative spirit of the power source; learning ability and innovation in the cultural force, and is the bridge and link them, it enables enterprises to obtain the accumulation of knowledge, but also To provide a knowledge base for innovation; innovative force in the outer core competitiveness, which enables enterprises to form the core of expertise, to enable enterprises to finally gain a competitive advantage in market competition (Ghemawat 2003). Therefore, the three forces combined to form the core competitiveness of enterprises is the real source of competitive advantage. Due to limited space, here we focused on the innovation ability of the core competitiveness.

172.4 The Influence of the Innovation to the Formation of Core Competitiveness

172.4.1 System Innovation and Core Competitiveness

A good enterprise systems to enable businesses to the effective functioning of the work, and an old, backward, non-enterprise system innovation, enterprise development will be seriously restricted the shackles (Glimstedt 2006). Enterprise system and the enterprise of core competitiveness, mainly in the ownership structure of corporate governance on the structure and behavior. This mainly refers to the structure of property rights ownership concentration and shareholder composition. If the goal of an enterprise's behavior tends to short-term goal, it will ignore the core competitiveness of the long-term goals; If an enterprise incentive and constraint mechanism is not perfect, cultivating core competitiveness of enterprises will lose the momentum and pressure; if the right of a business unclear responsibilities, decision-making, implementation and monitoring mechanisms are inadequate, and cultivate core competitiveness can never achieve the goal. All of these are cultivating core competitiveness must have the institutional basis.

172.4.2 Technological Innovation and Core Competitiveness

For enterprises, the technology is the enterprise survival and development. Technological innovation is the core source of competitiveness (Hennart 2001). An enterprise to form and improve their core competitiveness must have its own core technology. Like other things in the world, companies have their production, development, decline and extinction of the life cycle, but different companies there is a huge difference in the life cycle, and some short-lived, but some enduring (Rugman 2001). The world's leading large enterprises has been able foothold in their respective industries; the key point is that they not only have the core products, but also to ensure the upgrading of its core products (Hu 2008).

Every business has technical capabilities, but not every company has its core competitiveness (Rugman 2002). Only when the internal technological capabilities of enterprises and technological innovation to support their core technologies used to produce, and penetrate to the core products, and heterogeneity, permeability, give the user to create unique value will constitute the core competitiveness of enterprises (Lazonick 2007). In here, the technical capacity of enterprises is the basis of core competencies; unique technological innovation capability is the direct source of core competitiveness, only the technical innovation capability to make technological innovations into real core competitiveness.

172.4.3 Organizational Innovation and Core Competitiveness

In general, the corporate strategy decides the organizational structure, business strategy because of the specific requirements of the appropriate organizational structure as protection. Drastic changes in the external environment, the modern to the core competitiveness of enterprises should be constructed as the center of corporate strategy. Accordingly, the restructuring of business organizations have to nurture and enhance the core competitiveness principle. For businesses, organizations, innovation is important to enhance the competitiveness of enterprises and the basic means (O'Sullivan 2000). As one president said, we hope to have the core technology, but we first need to have to produce the core technology R&D system; we want our product quality is first class, but first we need to produce first-class production system and quality assurance system; Likewise, we hope sales continue on the stage, but we must first establish a well-developed, sound marketing network and customer service system. All in all, cultivating core competitiveness of enterprises can not do without organizations.

172.4.4 Culture of Innovation and Core Competitiveness

Culture generally refers to the internal shared fundamental values and a series of codes of conduct, its essence is the internal values. As mentioned earlier, the origin of competitive advantage is the culture, learning and innovation ability of organic combination. Cultural force in the center, learning ability, the spirit of innovative power sources, we can see, culture and innovation is to nurture and enhance the core competitiveness of enterprises key to the formation of the enterprise innovation internal source of power (Williamson 1999). Faced with increasingly fierce competition in domestic and international market environment, more and more enterprises recognize not only the ideological innovation is the soul of enterprise culture, is to continuously improve the key competitiveness of enterprises, and gradually in-depth corporate culture to implement innovative building at all levels to implement the practice of business management, corporate culture of innovation is being used by a new cultural ideas into improving the competitiveness of enterprises play a decisive role in the new management model, and has a strong relevance and importance practical significance.

172.5 Enhance the Enterprise Innovation Based on Core Competitiveness Perspective

172.5.1 We Should Pay Attention to the Concept of Innovation

Concept of innovation is the basis of innovation and an important component in the new situation. The concept of innovation is the business in order to achieve the overall optimization of efficiency, to break stereotypes, to overcome the shackles of old thinking and establish a new management concept. Every human society, a major change, always thinking of the concept of progress and update the guide, the development of enterprises, economic structure changes, too, is inseparable from the liberation of thought and ideas constantly updated, about the world of science and technology economic resources from the industrial economy or the economy to the knowledge economy, who can change ideas in time, one might seize the valuable time of social change and rapid development opportunities can be said that the innovative concept of deciding the life and death, while core competitiveness theory also emphasized the dynamic, requires a corresponding update to support the concept.

172.5.2 We Should Enhance the Customer Value

Creating customer value is the basis for enterprise survival and development, to adapt to meet the needs of the customer value in order to survive and profit; only create more customers than the value of its competitors in order to create competitive advantage, which is the core competitiveness theory core content. Thus, innovation must be market information, the greatest possible understanding of customer needs, requirements, preferences and buying patterns, identifying market opportunities, to the value provided by the enterprise level compared with competitors, find their weaknesses, or competitors, customer value has not been fully developed as a target product and market innovation, and create more customer value than competitors (Oliver 1997). This requires that our core competencies and have a clear understanding of their own to meet with the enterprise to carry out innovative activities, to create unique core competencies, and create the characteristics of the enterprise management unparalleled in the world (Hedlund 2007).

172.5.3 We Should Establish a Unique Corporate Culture

As if the soul of enterprise culture, mutual understanding between members of an enterprise product, is the enterprise system, the spirit of the unity of ethics and values. At present, China's enterprises to establish modern enterprise system in the context, should be cohesion, sense of people-oriented business philosophy and competitive corporate culture and other advanced equipment companies and their employees, so that business booming, invincible. Firstly, we should inherit and carry forward China's fine cultural traditions, including a positive attitude towards life, tenacious and regeneration ability of the assimilation of foreign culture and so on. On the basis of a strong traditional culture but also eradicate the feudal color, ultra-left brand of thinking, and incomplete formation of the rigid system of psychological and so on. Secondly, we should put the management is also productive thinking into the corporate culture builders, the real form of respecting knowledge and talents of good corporate cultural environment, and greatly improve the overall quality of staff work hard. Thirdly, companies must establish a comprehensive marketing culture for the concept of customer service, and strengthen the customer service-oriented corporate culture.

172.5.4 We Should Create a Learning Organization

The cultivation of core competitiveness of enterprises can not do without knowledge of the innovation, accumulation, transfer and sharing, which requires companies should become a learning organization and knowledge-based organizations in the ever-increasing practice in the specific assets of enterprises, not mimic recessive of knowledge. Peter Senge said when the world is more closely related to the complex, the ability to learn and more to enhance. In his The Fifth Discipline, the only sustainable competitive advantage may be competitors have to learn faster than your ability. Therefore, organizational learning and create a learning organization, through continuous learning, team learning and system learning, to enable enterprises to run in dynamic change, on the activation of the enterprise's internal resources, adapt to changes in the environment, nurturing core competencies and create sustainable competitive advantage of decisive significance.

172.6 Conclusion

Innovation is management activities which can promote the continuous economic growth carried out this activity requires a certain environment and institutional support. The practice of economic development in China note that if there is no good system arrangement, even with the new technology will be on the shelf. In summary, the enterprises innovation has profound and positive effect for the cultivation and development of the core competitiveness of enterprises, but the practice of foreign and domestic enterprises operating point of view, decentralization, and blind, messy business innovation can not achieve good results. We should treat the core competitiveness as the center to develop certain kinds of innovation in order to obtain the corresponding receipts, and to make the core competitiveness and innovation of the "locomotive" role play to each other.

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Chapter 173
An Application of Patent Strategy in Medium-Small Enterprises Product Innovation Process

Jiang-tao Zhan and Jia Yan

Abstract This paper analyzes the situation which domestic medium-small enterprises face now and applies an effective method using patent strategy to improve the product innovation process in medium-small enterprises. The effectiveness of this method is demonstrated in a design case which formed the main structure of a child safe car seat.

Keywords Design method · Medium-small enterprises · Patent strategy · Product innovation

173.1 Introduction

Medium-small enterprises play an important role in national economy. According to the latest data, there are more than 3.6 million medium-small enterprises in china. This medium-small enterprises group provides approximately 3 quarters working opportunities in industry field, and creates up to 55 % of gross national product and 46 % of national revenue. In contrast to the gorgeous data mentioned above, the average life span of medium-small enterprises is less than 3 years (Mao). This dilemma of medium-small enterprises becomes a study focus in industry field and academic circles. Scholars put forwards several reasons to explain this question, summarized as follows: (1) lack of competitiveness due to weakness of brand consciousness; (2) heavy tax pressure and shortage of workers;

J. Zhan (✉)
Institute of Design and Art, Zhejiang Institute of Mechanical and Electrical Engineering, Hangzhou, China
e-mail: sdzhanjt@163.com

J. Yan
Institute of Information Technology, Zhejiang Business College, Hangzhou, China

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(3) insufficient product innovation capability which can not support medium-small enterprises to keep sustainable development (Jiang and Li 2007).

In this paper, a patent strategy will be presented for medium-small enterprise to improve their product innovation capabilities.

173.2 Present Situation of Product Innovation in Medium-Small Enterprises

Product innovation is an important foundation for medium-small enterprises. Through a series of product innovation activities, such as creating new products, renewing old products, and increasing added-value of developed products, medium-small enterprises can establish local advantage in product market, and then obtain sustainable competitiveness ability.

But the actual situation is that quite a number of medium-small enterprises in China are small and in low level industry, which is the main cause of low competitive ability. As the same time, for the lack of capital and the shortage of talents, medium-small enterprises can not afford an entire range of product innovation, but only can focus limited resource to practical product or service. Characteristic products are the foothold of medium-small enterprises, and product innovation is the source of characteristic productions. Only by continuous production innovation activity and meeting customer requirements, medium-small enterprises can keep sustainable development.

Though medium-small enterprises can not afford an entire range of production innovation, there are still some product innovation strategies can be taken, domestic scholars put forward a series of ways to proceed production innovation, such as increasing investment on product innovation, absorbing more talents, strengthening cooperation with scientific research units, etc., (Liang 2001; Duan 2009). However, these product innovation strategies are long-term methods, and can not meet the rapid changes occurred in market. Compared with these strategies mentioned above, the one that can adapt to the rapid changes based on actual situation is much suitable for medium-small enterprises.

173.3 Patent and Product Innovation Method Based on Patent Strategy

Patent is a kind of summarized technical document, which can demonstrate technology development track and technical solutions. Patent is also a great technology source never used up for enterprises. By using patents, enterprises can forecast the trend of technology development, define the technology policies, avoid duplicating R&D, and enhance their capability of R&D. According to latest inquiry, using patent efficiently, 60 % R&D time can be shortcut, and 40 % R&D money can be saved. In knowledge economy time, patent has become an important weapon to defeat other enterprises in market. Accordingly, different kinds of patent strategies and product innovation methods based on patent strategies derived from patents.[1]

Under the condition of limited capital and shortage of technician, medium-small enterprises can overcome the obstacles in production innovation by putting patent factors into regular product design process. Meanwhile, only when technicians have related patent skill, such as searching and analyzing patents, building contradiction matrix and transferring and solving technical problem, the product innovation process based on patents strategy can be well executed.

In the following of this paper, a patent strategy based product innovation method will be introduced to show the effects of patents strategy on product innovation proceeded in medium-small enterprises (Yu et al. 2011). This method includes 4 steps to solve product innovation problem.

STEP 1: The first task is searching related patent, simplifying technical document, and organizing technical information.

STEP 2: A "function-technique" matrix should be set up. And this matrix is also a foundational base to the patent strategy based product innovation method (Terninko et al. 1998; Nydegger and Richards 2000; Oakley 1990; Savransky 2000).

STEP 3: Using the function-technique matrix, technicians choose a target patent from the series of patents gotten in STEP 1. Technicians can easily get the technical solution corresponding to the technique trouble mentioned in this patent. Then technicians can use the theory of TRIZ to design around target technical solution. With the help of 39 engineering parameters and 40 inventive principles in TRIZ, technicians can effectively complete this work (Sickafus 1997; Ullman 1997; Otto 2001; Archer 1984).

STEP 4: Based on the result of STEP 3, technicians can develop a new structure prototype, which has totally different technical characters compared with the target patent.

173.4 An Application Experiment Executed in a Medium-Small Enterprise

173.4.1 The Background of the Enterprise

Ningbo Yijia Car Electrical Apparatus Company locates in Ningbo, China. Its main products are car auxiliary products, such as emergency air compressor, emergency battery, and child safe car seat. This company has about

[1] Information on http://baike.baidu.com/view/50915.htm

150 employees, including 2 electrical engineers, 2 product designers and 2 structure engineers. In this experiment, a slide way structure embodied in child safe car seat is the target of product innovation.

173.4.2 Patent Search and Analyses

Firstly, we can index the patent sources by "child safe car seat" and "slideway structure" and obtain preliminary 135 patents. For the slideway structure is the innovation target, 9 patents related slideway structure, shown in Table 173.1, are picked out to patent-around design and a "function-technique" matrix is set up based on these 9 patents, shown Table 173.2.

173.4.3 Establishing and Solving Design Problem

Through the "function-technique" matrix, we noticed that No. 2 patent meets almost the technical requirements in the matrix comparing with the others. It shows that No. 2 patent could be the target patent to be patent-around designed. The structure of No. 2 patent is shown in Figs. 173.1 and 173.2.

Simplifying the patent document, we can obtain the following technical information:

1. There are two slideway on each side of seat, which assembled in chair base;
2. Chair body is locked to chair base by a spring bar;
3. Pulling out the spring bar, the chair body can slide along to the slideway structure.

In this experiment, the innovation target is the slideway structure, which should be easy to operate, safe and simple. In the next step, we will use TRIZ contradiction matrix to solve the innovation problem and design a new structure, shown in Table 173.3.

Table 173.1 Result of patent index

	Patent No.
No. 1	DE19850961A1
No. 2	EP084068A1
No. 3	EP1625968A1
No. 4	FR2778376A1
No. 5	JP2001328470A
No. 6	JP2002301960A
No. 7	US2002060483A1
No. 8	US2006181125A1
No. 9	W09954160A1

Table 173.2 Function-technique matrix

	Operate easily	Safety	Manufacturability	Simple and firm
No. 1	■			
No. 2	■	■	■	□
No. 3	■		□	
No. 4	□	□	□	
No. 5		■		
No. 6	■			■
No. 7	□	■		□
No. 8		■		
No. 9	■		□	

■good, □normal

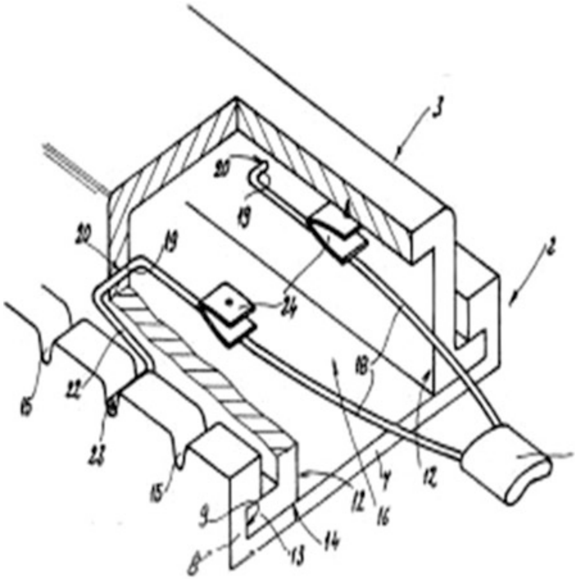

Fig. 173.1 Slideway structure

Following the advice given by TRIZ contradiction matrix, a new slideway structure and a new lock structure are designed, shown in Figs. 173.3 and 173.4:

In the final step of this product innovation process, we compare the new structure with No. 2 patent, it can be concluded that the two structures are obviously different. In another words, there is no patent violation between the two structures and we get a new child safe car seat design scheme.

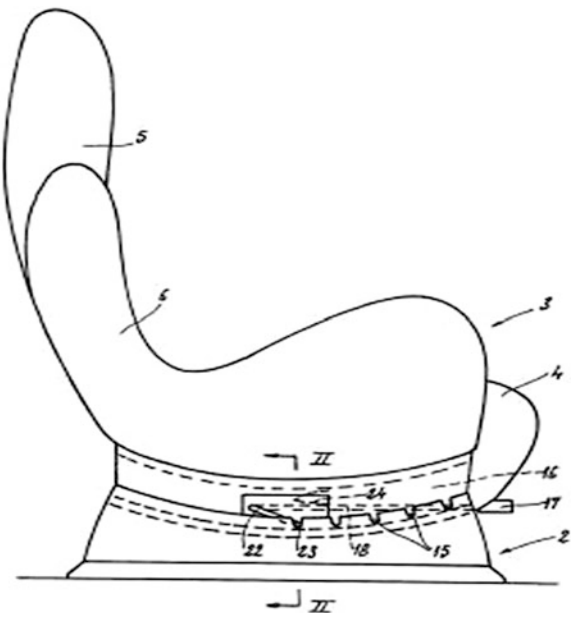

Fig. 173.2 Slideway structure

Table 173.3 Triz contradiction matrix

	Engineering parameters	Advice for patent-around
1	No. 36: Complexity of device	Making lock structure to be an independent part by dividing it from chair body
2	No. 26: Copying	Keeping the two slideway structure
3	No. 33: Convenience of use	Transforming the pull handle into knobs which locate in each side of the car seat
4	No. 9: Prior counteraction	Rotating the lock action from open to close

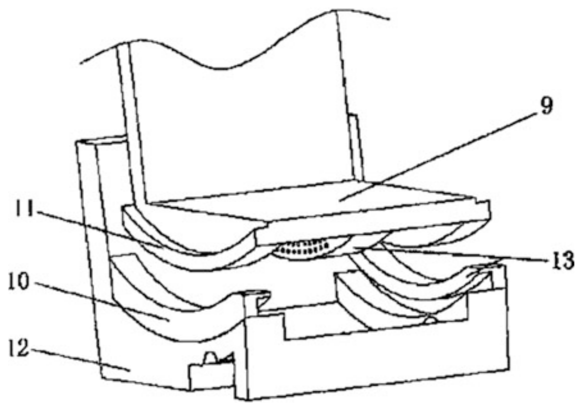

Fig. 173.3 New slideway structure

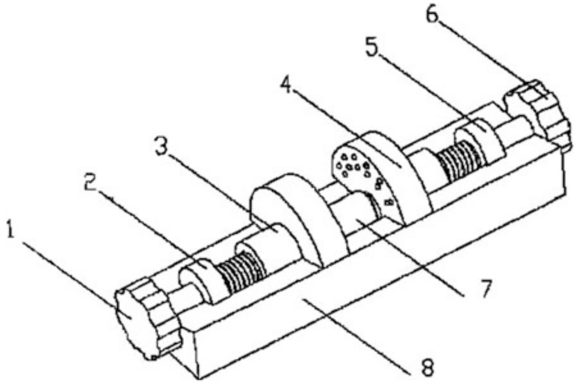

Fig. 173.4 New lock structure

173.5 Summary

This experiment took 23 working days totally, and the design team consists of 2 product designers who are in charge of patent index and analysis, and 2 structure engineers who are in charge of design new structure according to patent strategy. Compared with previous experience, this product innovation method took less time, technicians and money, and technicians are clear in duty and have high design efficiency. All the advantages base on actual situation of product innovation in medium-small enterprises, no further more capital investment and no further more technicians requirement. The most important thing is that this innovation process can act upon the rapid change of product market. This conclusion also shows that patent strategy based product innovation method can help medium-small enterprises to solve the dilemma of their product innovation.

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Chapter 174
The Empirical Study on Influencing Mechanism of Firm's Entrepreneurial Behavior in Manufacturing Clusters

Zheng Ye and Ning Cai

Abstract Based on questionnaires surveyed in manufacturing clusters in Zhejiang province, this paper studied the influencing mechanism that network characteristics of firms in cluster and their entrepreneurial behaviors through the mediating role of entrepreneurial capability. The results of empirical analysis indicate that: First, relation content and betweenness centrality are positively related to the three dimensions of entrepreneurial capability which include entrepreneurial cognitive capability, opportunity access capability, and resource integration capability. Second, tie strength and network intensity are positively related to entrepreneurial cognitive capability and resource integration capability, but negatively related to opportunity access capability. Network scale only has positive relation to resource integration capability. Results showed that it is one of the key approaches to improve entrepreneurial behaviors through cultivate the entrepreneurial capability based on the network characteristics of firms in clusters.

Keywords Empirical study · Entrepreneurial behavior · Influencing mechanism · Manufacturing clusters

174.1 Introduction

Firms in clusters are embedded in a local network constituted with formal and informal relationships, and the local network is the main way of knowledge spillover effect and cluster upgrading. The entrepreneurial decision behaviors of network

Z. Ye (✉)
Hangzhou Vocational and Technical College, Hangzhou, China
e-mail: zjuyz2008@gmail.com

Z. Ye · N. Cai
College of Public Administration, Zhejiang University, Hangzhou, China

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members have great differences with the decision behaviors of independent firms. On the one hand, the multiple network relationships of firms in clusters make imitation and innovation more likely to occur. On the other hand, the embeddedness of firms in clusters is easy to cause the path dependence and lock (Uzzi 1997). Both these will have effect on entrepreneurial behaviors. This paper is to reveal the influence mechanism on entrepreneurial behavior of firms in clusters with the point that industrial cluster is a complex social network organization.

174.2 Methodology

174.2.1 Entrepreneurial Capability and Entrepreneurial Behaviors Analysis

Entrepreneurship is the behavior that the entrepreneur uses its unique quality perception to catch the entrepreneurial opportunity and conduct the integration of resources to create innovative products or services to achieve its potential value. Entrepreneurship not only occurs in individuals to start new enterprises but also exists in exiting enterprises with the entrepreneurial activities of innovation, risk taking, actions ahead (Zahra 1993). Entrepreneurial behavior has great relationship with entrepreneurial capability such as entrepreneurial cognitive capability, access capabilities, and the ability to integrate resources (Shane 2003). Initiative, imagination, creativity, flexibility, and the ability of willing to rational thinking is the main unique entrepreneurial cognitive capability which is the fundamental of entrepreneurial behavior (Stevenson and Jarillo 1990). The entrepreneurial opportunity access capabilities are the ability to contact, identify and catch opportunity. Shane (2000) pointed that perceiving opportunities is actually a processing of information collection and recognition, choosing the right opportunity is the main capability of entrepreneurs to successfully develop new business. The ability to integrate resources is the ability to comprehensively allocate and coordinate various resources to use the opportunity (Birley 1985). Entrepreneurial resources refer to the total various tangible and intangible resources inside or outside the enterprise that the enterprise has input and utilized in the business process (Brush et al. 2001).

Hypothesis 1a Entrepreneurial cognitive capability has a positive influence on entrepreneurial behavior.
Hypothesis 1b Entrepreneurial opportunity access capability has a positive influence on entrepreneurial behavior.
Hypothesis 1c Entrepreneurial resource integration capability has a positive influence on entrepreneurial behavior.

174.2.2 Network Characteristics and Entrepreneurial Capability Analysis

According to the network embeddedness theory, the economic behaviors of actors are affected by the relations with their neighbors and the location in whole network at the same time (Hagedoom 2006).

1. *Network relation and entrepreneurial capability* With the neighbor effect, individual decision-making processes are easy to be affected by the neighbors' selection (Manski 2000). Network intensity or frequency is important index to represent the characteristics of the relationship between firms in the local network. Strong links can promote trust and cooperation between firms, and help firms easy to catch more resources such as refined, high-quality information and tacit knowledge, and can quickly change the market opportunities into reality activities (Honig and Davidsson 2000). 1990895 But some predict that weak links lead to a loose contact relationship which increase the network relationship diversity and provide more access to different types of new information, people and resources (Granovetter 1985). Network content mainly refers to specific character or type of the links between various actors (Barnes 1983). Relationships between actors have different content even in the same network. Entrepreneurs can obtain information and integrated technology from the important channel of distributors, suppliers, competitors and customers relations (Brown and Butler 1995).

Hypothesis 2a Strength of network relationship has a positive influence on entrepreneurial cognitive capability.

Hypothesis 2b Strength of network relationship has a negative influence on access capacity.

Hypothesis 2c Strength of network relationship has a positive influence on resource integration capability.

Hypothesis 3a Network content has a positive influence on entrepreneurial cognitive capability.

Hypothesis 3b Network content has a positive influence on access capacity.

Hypothesis 3c Network content has a positive influence on resource integration capability.

2. *Network structure and entrepreneurial capability* Social network theory emphasizes that the actor's position in the social structure determines its opportunities and constraints (Stuart and Sorenson 2005). Network scale is the most commonly used index, which is defined as the number of the direct links that center actor with other actors. Network scale indicates the main existing channels and a larger network scale means the firms in clusters have more funding and human resources, more potential customers and suppliers, have strong influence in the industry and more industry experience and knowledge (Granovetter 1985). Network density is the index that actual links divide all

possible links of network. High density network is more prone to share tacit knowledge and expand the association of knowledge and information resources can be integrated, which guarantee the strong control of certain resources and improve the possibilities of resource integration (Baptista 2000). Zhao (2008) pointed out that the intensive association link represents a wider range of resources allocation and more rapid efficiency of resource allocation. But on the other hand, the centralized transactions of the network members reduce the new opportunity path for firms to obtain useful information and knowledge from outside world (Burt 1992). Betweenness centrality is one of the three kinds of network central index put forward by Freeman (1979), is particularly suited for the assessment the power of actors in the network. It means the actors occupy the middle position in the shortest path between two actors and connect both the actors. Firms occupy the position of structural holes can get multidimensional non repetitive information, and become the distributing center of information.

Hypothesis 4a Network scale has a positive influence on entrepreneurial cognitive capability.

Hypothesis 4b Network scale has a positive influence on access capability.

Hypothesis 4c Network scale has a positive influence on resource integration capability.

Hypothesis 5a Network density has a positive influence on entrepreneurial cognitive capability.

Hypothesis 5b Network density has a negative influence on access capacity.

Hypothesis 5c Network density has a positive influence on resource integration capability.

Hypothesis 6a Betweenness centrality has a positive influence on entrepreneurial cognitive capability.

Hypothesis 6b Betweenness centrality has a positive influence on access capacity.

Hypothesis 6c Betweenness centrality has a positive influence on resource integration capability.

174.2.3 Conceptual Model

On the basis of the analysis of network characteristics, entrepreneurial capability and entrepreneurial behaviors, this paper put forward the research model (Fig. 174.1). Entrepreneurial behavior of firms in clusters is dependent variable. The independent variables are network characteristics of firms in clusters with two dimensions of network relation and network structure. Network relations include strength of network relationship and network content. Network structure includes network scale, network density and betweenness centrality. The intermediate variables are entrepreneurial capability of firms in clusters including entrepreneurial cognition ability, access capability and resource integration capability.

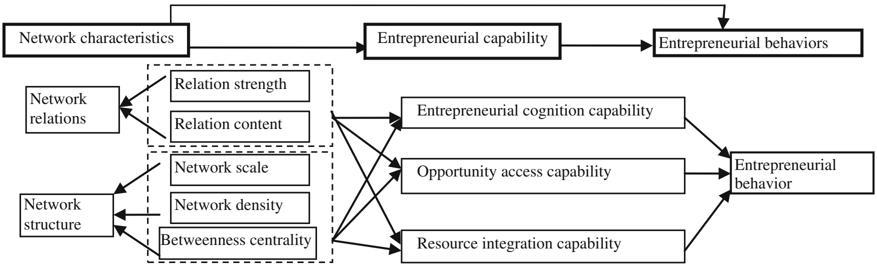

Fig. 174.1 Conceptual model of network characteristics influences to entrepreneurial behavior

174.2.4 Data Gathering and Analysis

Zhejiang has a high proportion of manufacturing industries compared with that of China and the manufacturing industry contributes almost 40 % of Zhejiang's GDP. This paper selects three manufacturing industrial clusters in Zhejiang province to do the survey. They are Dongyang electronic magnetic materials industrial cluster, Jinhua automobile industrial cluster and Lanxi cotton textile industrial cluster. Formal questionnaires released to the senior manager of the firms in these clusters and the recovery lasts nearly 5 months objects include. In the total 300 questionnaires released, 141 are retrieved and 132 of them are effective. The overall effective questionnaire recovery rate is 44 %. The scale development for the questionnaire is mainly based on the related literature.

Considering the variables of network characteristics and entrepreneurial capability involved in the conceptual model are too complex and difficult to directly measure, it will be hard to get ideal result with the method of multiple linear regression. This paper uses the method of structural equation modeling (SEM) to verify the above hypothetical concept model. The software AMOS 7.0 (Analysis of Moment Structures) is used to realize the analysis process. Before the operation of AMOS, we analysis and test the rationality and validity of the data, including sample size, the distribution of sample data and data reliability and validity. In a large number of models evaluation index, we selected $\chi 2$, $\chi 2$/df, NFI, CFI, RMSEA and SRMR as fit index to evaluating the model.

174.3 Results and Discussion

It is rare that a model fits well at first, and the revised model of this paper obtains superior goodness of fit (Table 174.1). $\chi 2$/df is 1.950 which is smaller than 2, means that the fitting effect can be accepted. RMSEA is 0.055, which is between the acceptable intervals from 0.05 to 0.08. SRMR is 0.073, which is less than 0.080. NFI is 0.937 and CFI is 0.968, both of which are bigger than the reference value of 0.900. The C.R. values corresponding to the path coefficients in the

Table 174.1 The fitting calculation results of the revised model

	S.E.	C.R.	*P*		S.E.	C.R.	*P*
λ_{11}	0.383	3.153	0.002	λ_{31}	0.302	3.001	0.006
λ_{12}	0.551	2.396	0.017	λ_{32}	0.102	2.433	0.013
λ_{14}	0.178	3.603	0.000	λ_{33}	0.128	−2.438	0.015
λ_{15}	0.331	1.991	0.045	λ_{34}	0.156	2.681	0.007
λ_{21}	0.220	−2.023	0.028	λ_{35}	0.289	2.547	0.011
λ_{22}	0.120	2.424	0.011	β_{11}	0.084	5.002	0.000
λ_{24}	0.242	−1.970	0.050	β_{12}	0.158	2.751	0.006
λ_{25}	0.106	2.011	0.033	β_{13}	0.087	4.958	0.000
$\chi 2$		296.523		NFI		0.937	
df		152		CFI		0.968	
$\chi 2$/df		1.950		RMSEA		0.055	
P		0.000		SRMR		0.073	

structural equation model are bigger than the reference value of 1.96, and statistically significant in the level $P \leq 0.05$.

According to the revised model in Fig. 174.2, hypotheses 1a, 1b, 1c are verified, indicating the significant positive influence that entrepreneurial cognitive capability, entrepreneurial opportunity access capability and resource integration capability have on entrepreneurial behavior. In addition, hypotheses 2a, 2b, 2c, 3a, 3b, 3c, 4c, 5a, 5b, 5c, 6a, 6b, 6c passes test. These indicate that strength of network relationship has a positive influence on entrepreneurial cognitive capability and resource integration capability, but has a negative influence on access capacity. Network content has a positive influence on entrepreneurial cognitive capability, access capacity and resource integration capability. Network scale only has a positive influence on resource integration capability. Network density has a positive influence on entrepreneurial cognitive capability and resource integration capability, but has a negative influence on access capacity. Betweenness centrality has a positive influence on entrepreneurial cognitive capability, access capacity and resource integration capability. Hypotheses 4a, 4b are not verified, which

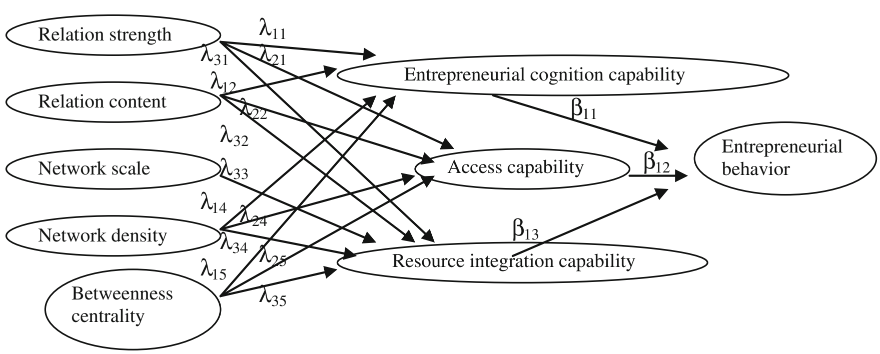

Fig. 174.2 The revised model

indicates there is no significant influence between network scale and entrepreneurial cognitive capability and access ability. Currently, there are still few regional entrepreneurial policy in the industrial clusters in Zhejiang province, and entrepreneurial cognition and entrepreneurial opportunities of firms in clusters comes more from public training and public information outside the clusters.

174.4 Conclusion and Inspiration

This paper finished the empirical study of influence mechanism analysis between network characteristics and their entrepreneurial behaviors of firms in clusters. The results show that entrepreneurial cognitive capability, entrepreneurial opportunity access capability and resource integration capability have significant positive influences on entrepreneurial behavior. Relation content and betweenness centrality are positively related to the three dimensions of entrepreneurial capability. Tie strength and network intensity are positively related to entrepreneurial cognitive capability and resource integration capability, but negatively related to opportunity access capability. Network scale only has positive relation to resource integration capability. This result may provide another way for local government of clusters to analyze the entrepreneurial policies. For example, the core firms with strong ties, rich relation content, big network density and betweenness centrality usually have strong entrepreneurial cognitive capability and resource integration capability. They are conducive to the entrepreneurial behaviors. The local government should pay more attention to how to improve their opportunity access capability to avoid the situation of ignoring opportunity discovery, creation and access which is caused by excessive embedded. To the other firms in clusters, the local government should pay more attention to improve their entrepreneurial cognitive capability and resource integration capability with the consideration on their network characteristics. Then entrepreneurial behavior can first occur in clusters and its diffusion to other firms becomes possible. To make the most of the research result, a further and deeper research on entrepreneurial policies of local government is recommended.

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Chapter 175
The Research on Enterprises Organizational Innovation Path Factors Impact on the Organizational Innovation Decision-Making

Peng Wang and Chun-sheng Shi

Abstract In order to describe the enterprises organizational innovation path factors impact on the organizational innovation decision-making, this thesis had taken the enterprises organizational innovation path reality implementing character and innovation decision-making content into consideration, then conclude three distinguished organizational innovation path type and two kinds of organizational innovation decision-making factors. Then based on the theatrical model and relate hypothesis, use SEM (structure equation modeling) to vivificate the different enterprises organizational innovation path factors impact on the organizational innovation decision-making. The final answer shows that: the enterprises organizational innovation path factors can effect on each other, and the radical organizational innovation path, mild organizational innovation path, and conservative organizational innovation path had positive impact on organizational innovation decision-making, the radical organizational innovation path ad the biggest impact on organizational innovation decision-making.

Keywords Organizational innovation path · Organizational innovation decision-making · SEM (structure equation modeling)

175.1 Introduction

For modern enterprises, the most important mission for the enterprises management is how to give empirical support of the organizational innovation decision-making which located in the organizational innovation path (Cao-zhi et al. 2001). But, the enterprises resource is limited, the organizational innovation path as the operate

P. Wang (✉) · C. Shi
College of Management, Harbin Institute of Technology, Harbin, Heilongjiang, China
e-mail: 18746040895@163.com

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planning for coordinating the organizational innovation content and direction can make the resource scarce, so the enterprises should make macro navigate for the resource planning, and the organizational innovation decision-making should consider the different organizational innovation path impact on the organizational innovation decision-making degree (Cheng and Lu 2004). This thesis is based on the different organizational innovation path, conclude three path as following shows: (radical organizational innovation path, mild organizational innovation path, conservative organizational innovation path), then use the three path to explore the impact of the organizational innovation decision-making (Zhang et al. 2010). Use the SEM and asking paper method to modify the organizational innovation path impact on the organizational innovation decision-making theatrical model. Then give concrete analysis of the empirical research answer. Finally, give a few suggestions for improving the organizational innovation decision-making abilities.

175.2 The Construction of the Organizational Innovation Path Impact on Organizational Innovation Decision-Making and Research Hypothesis

Based on the reality enterprises organizational innovation path, the reason why there exists different path type is because there are so many motivation elements. But when the enterprises make organizational innovation planning, it should consider the organizational innovation path impact on the organizational innovation decision-making (Duan and Lu 2001). Then based on the above analysis, this thesis construct theatrical model of the organizational innovation path impact on the organizational innovation decision-making (as Fig. 175.1 shows). The theatrical model of the organizational innovation path impact on the organizational innovation decision-making includes three levels and three aspects and many factors (as Fig. 175.1 shows).

The three levels which Fig. 175.2 mentioned are radical organizational innovation path, mild organizational innovation path, conservative organizational innovation path; they are the core three type of the organizational innovation. The radical organizational innovation path is affected by organization scale, organization method, and organization culture. The mild organizational innovation path is affected by market pushing, government inducing and technical innovation. The conservative organizational innovation path is affected by management level, enterprises will, and operates method. The organizational innovation decision-making can distinguish to research degree, decision-making degree and opening up degree.

Then based on the above discussion, this thesis gives following research hypothesis:

H1 The radical organization innovation path had direct positive impact on mild organization innovation path.

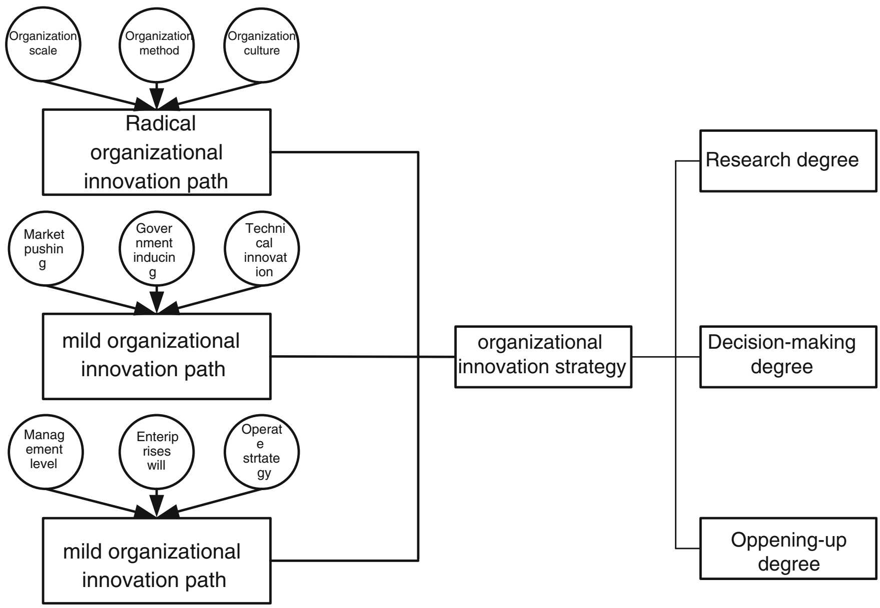

Fig. 175.1 Theatrical model of the organizational innovation path impact on the organizational innovation decision-making

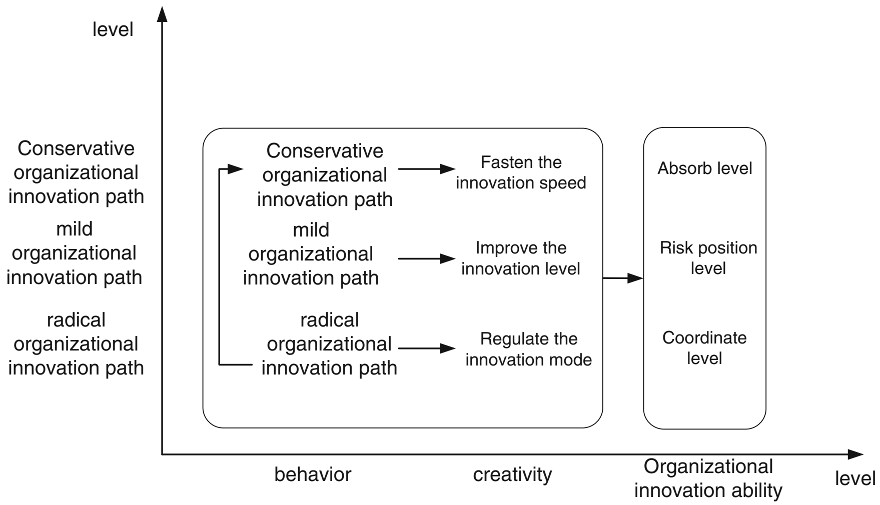

Fig. 175.2 Theatrical model of the organizational innovation path impact on the organizational innovation decision-making elements

H2 The mid organization innovation path had direct positive impact on conservative organization innovation path
H3 The conservative organization innovation path had direct positive impact on radical organization innovation path.
H4 The radical organization innovation path had direct positive impact on organization innovation decision-making.
H41 The reconstruct the organization scale had direct positive impact on organization innovation decision-making.
H42 The regulate the organization method had direct positive impact on organization innovation decision-making.
H43 The enhancement of the organization culture had direct positive impact on organization innovation decision-making.
H5 The mild organization innovation path had direct positive impact on organization innovation decision-making.
H51 The market pushing had direct positive impact on organization innovation decision-making.
H52 The government inducing had direct positive impact on organization innovation decision-making.
H53 The deepening technical innovation had direct positive impact on organization innovation decision-making.
H6 The conservative organization innovation path had direct positive impact on organization innovation decision-making.
H61 The optimize management level had direct positive impact on organization innovation decision-making.
H62 The construction of the enterprises wish had direct positive impact on organization innovation decision-making.
H63 The focus on the marking method had direct positive impact on organization innovation decision-making.

175.3 The Empirical Verify of the Theoritical Model

So in order to describe the measurement table more specific, this thesis is based on the original asking paper qualification, then use the big scale consulting method to illustrate the investigating item, then the asking designing as Table 175.1 shows.

Table 175.1 The designing of the asking paper item

Measure content	Measure elements	Measure amount
Radical organization innovation path (ROI)	Organization scale (OS)	3
	Organization method (OM)	3
	Organization culture (OC)	4
Mild organization innovation path (MOI)	Market pushing (MP)	4
	Government inducing (GI)	3
	Technical innovation (TI)	2
Conservative organization innovation path (COI)	Management level (ML)	2
	Enterprises will (EW)	3
	Operate way (OW)	4
Organization innovation decision-making path (OID)	R&D degree (RD)	2
	Decision-making degree (DM)	3
	Opening-up degree (OD)	4

175.4 The Empirical Answer Analysis

175.4.1 The Qualification of the Relate Data

The variable reliability use the Cronbach's a coefficient inspection, generally speaking, if $a > 0.7$ belongs to high reliability, the factor load exceed 0.3, we recognize it as the general, we should keep it, if exceed 0.4, we recognize it as the more important, if exceed 0.5, we recognize it as the most important (Wang 2006). We analysis and measure the Cronbach's a coefficient through all kinds of the asking paper's factor. The final answer shows, the factor coefficient answer is larger than 0.7, we can accept the answer and the index answer factor load is above 0.5, that illustrate all kinds of the element are exists consistency and stability (as Table 175.2 shows).

175.4.2 The Discussion of the SEM

In order to inspect and verify the organizational innovation dynamic evolution model and relate hypnosis, this thesis applied AMOS software to construct SEM, then inspect the fitting degree of the theatrical model and the reality evaluate data, the concrete fitting degree and measure answer as Table 175.3 shows (Wu 2008). All kinds of the fitting degree index belong to critical space. And the model standard coefficient is smaller than 1, the evaluate answer is not exist high relate type, that shows the fitting of the SEM and the data is locate in good mode.

According to the Cohen research on the path index, the path item and the potential index exists strong relationship. The absolute answer is lower than 0.1,

Table 175.2 Variable reliable and validity inspection

First level potential variable	Second level potential variable	Second level potential variable	Second level potential variable	
Conservative organizational innovation path	Department coordinate innovation (DCI)	0.534	0.758	0.775
	Organization institution innovation (OII)	0.649	0.804	
Mild organizational innovation path	Business mode innovation (BMI)	0.755	0.746	0.804
	Customer service innovation (CSI)	0.521	0.758	
	Stimulate test system innovation (STSI)	0.729	0.754	
Radical organizational innovation path	Mathod innovation (SI)	0.764	0.729	0.822
	Organization ability innovation (OAI)	0.861	0.843	
	Technical innovation (TI)	0.779	0.881	
Organizational innovation level	Absorb level (AL)	0.771	0.827	0.754
	Risk position level (RPL)	0.796	0.855	
	Coordinate ability (CA)	0.805	0.799	

Table 175.3 The final answer of the SEM fitting inspection

Index character	Fitting index	Recommend standard	Measure answer
Absolute fitting index	(χ^2/df)	≤ 3.000	3.563
	(RMSEA)	≤ 0.100	0.067
	(GFI)	>0.800	0.835
	(SRMR)	<0.080	0.078
Relate fitting index	(NNFI)	>0.800	0.693
	(NFI)	>0.800	0.754
	(RFI)	>0.800	0.828
	(IFI)	>0.800	0.762
	(CFI)	>0.800	0.757
Simple fitting index	(PCFI)	>0.500	0.521
	(PNFI)	>0.500	0.417

the absolute answer locate between 0.1 and 0.5 is mild level, the absolute answer is larger than 0.5 is huge effect (Guaglianone 2012).

175.4.3 The Empirical Answer Analysis

From Fig. 175.3 we can see that, the three kinds of the path impact on the organizational innovation level standard is 0.525 (Li 2011), according to the research on the path coefficient scale and the relationship between path coefficient and

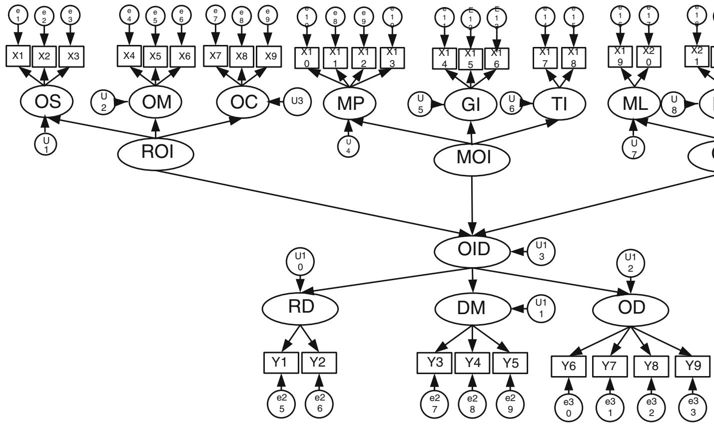

Fig. 175.3 Correcting structural equation modeling

potential variables, when the absolute answer is smaller than 0.1 (Ming 2010), we can recognize it as the smaller effect, we the answer is locate between 0.1 and 0.5 (Wong 2011), we can recognize it as the mild effect, when it larger than 0.5 (Chun-Ming 2007), we can recognize it as the big effect. So it proves that the three kinds of the path show obvious impact on the organizational innovation level.

175.5 Conclusion and Enlighten

This thesis is based on the construction of the enterprises organizational innovation path impact on organizational innovation decision-making theatrical model and research hypothesis, use the SEM method to verify and inspect the theatrical model. The final answer shows that the three kinds of the innovation path show obvious impact on the enterprises organizational innovation path. The radical organizational innovation path had biggest impact, the mild organizational innovation path locates second, and the conservative organizational innovation path is the last. When the enterprises make resource distribute according to the organizational innovation decision-making, it should focus on the organizational strategy and the coordinate between organizational scale and organizational ability, and cultivate specific organization culture, at the same time, the enterprises should also focus on the technical pushing ability and marketing strategy.

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Chapter 176
Theoretical Perspective in Innovation Management Implementation: A Literature Review

Ming-zhu Zhu

Abstract Innovation plays an important role in the economic and social development during the knowledge economy. Economic and social development requires various innovation activities necessarily. Innovation management is to manage these innovative activities in order to ensure the realization of the goal and the optimal efficiency. Thus, innovation management draws the attention of the management academia and social public. Beginning with the background of innovation management, this paper will summarize the research achievements of domestic and foreign scholars on innovation management, and then review the concept evolution of innovation management, relative theoretical studies and classifications, enumerate innovation management tools, and finally propose the scientific problems of innovation management.

Keywords Innovation · Innovation management · Innovation management tool

176.1 Introduction

The development of economy and society requires inevitably a wide range of innovative activities, such as research and development innovation, production process innovation, management innovation, marketing innovation etc. Each activity needs the innovation in the long run, and the innovation needs the resource. The available resources are limited in a period of time, so it is necessary to prioritize each innovation and make an overall arrangement. The purpose of innovation management is considered from three aspects. (1) Innovation needs guidance. Decision-making process of the innovative should be managed, because

M. Zhu (✉)
College of Management and Economy, Tianjin University,
Tianjin, China
e-mail: dorothyhatty@126.com

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not all new things are good (Mikkola 2001). (2) Innovation needs simulation. Innovation has uncertainty and risk, and the innovation is resisted due to the conservation of traditional practice, the fear of new things, and the concern on innovation failure. Therefore, innovation does not arise spontaneously in general, which needs innovation management to create an innovation system (Ning 2012). (3) Innovation needs coordination. Innovation resources can be allocated optimally through the coordination. Each subprocess and element can also interact efficiently and play an integral function. Obviously, innovation management is to manage innovation activities, to promote efficient innovation process, and to realize innovation object (Tomala and Sénéchal 2004).

Innovation is the origin of innovation management. Innovation was proposed as a theory for the first time by J.A. Schumpeter, a well-known economist. He analyzed three industrial revolutions in history and pointed out that technological innovation is a major origin of capitalism long-term fluctuation. The technological revolution drove the economic improvement (Schumpeter 1934). Innovation scholars and organizations following Schumpeter's footstep, developed innovative ideas further to make innovative content standardized and abundant. Rostow (1959), an American economist, developed the concept of "innovation" into "technological innovation". "Technological innovation" occupied a dominant position in the innovation. Myers and Marquis (1969), who were the main proponents and participants of the technological innovation of the U.S. National Science Foundation, regarded that the innovation was a whole process of interrelated subprocess, not a separate action. Innovation was not only a new creative concept, a new instrument invention and a new market development, but also a process that everything was acting jointly in an integrated way. Freeman (1982), a British economist, limited innovation object to standardized innovation basically. For the first time, he proposed that technological innovation meant the commercial conversion of new product, process, system and service. Some researchers believed that a technological innovation was not a technological invention, but was an innovation created by technology. It was measured by the following aspects: new markets opened through technological promotion, the stimulation of economic development, economic strength that could change society and life style rapidly (Adams et al. 2006).

According to innovation characteristics, Chinese scholars also defined the innovation combining with China's situation. Xu (2007), the professor of Zhejiang University, from the view of technological innovation, defined the innovation as all activities from a new idea to the successful commercial application. It included a series of scientific, technical and commercial activities from the idea of scientific discovery or invention to the research achievement promoted successfully in the market. Fu (1998), the professor of Tsinghua University, considered the activity process as a special technological innovation, such as seizing potential market opportunities, recombining production conditions, elements and organizations, and building the operation system with more efficiency and lower cost.

176.2 The concept Evolution of Innovation Management

The concept of innovation management has not been agreed in academia so far. The followings are three main kinds of innovation management summarized by domestic and foreign scholars.

176.2.1 Plan Innovation Management

Plan innovation management is to manage the processes of innovation. Innovation processes can be planned, organized, commanded, coordinated and controlled, that means it can be managed because of the common in the processes of innovation. The foreign scholars, such as Tidd, Bessant and Pavitt (2005), regarded that innovation was a process rather than a single piece. The process can be manipulated and affect the result. It is no random for enterprises to develop process technology and new products. Technological innovation is formed and occurs in an orderly manner at the framework with clear boundaries. Therefore, it is very important to draw up a formal plan and strive to control innovation during the innovation implementation. The domestic scholars, He et al. (2009) stated that innovation management was to plan, organize, command and control the innovative activities effectively in order to obtain comprehensive benefits and improve the market competitiveness of enterprises.

176.2.2 Random Innovation Management

Random innovation management is a nonlinear process because innovation activities are uncertainty. For the management of innovation process, there are serious limitations in formal plans, procedures and control systems. As Robinson et al. discussed (Robinson 1997), innovation process was a complex and nonlinear process, full of chaos. Most innovations are unexpected outcomes rather than planned outcomes. Innovations are discovered generally from relatively chaotic events, and their generation tends to be intermittent or disordered with many random interactions and accidents. The result is usually impossible to predict. In other words, the innovation is a random event, which is difficult to predict, plan and control. Therefore, formal plans, procedures and control systems have serious limitations for the management of the innovation process. Chen (2001) presented that economic development, material abundance and cultural prosperity caused by the innovation were based on people's need. Innovation is an independent action of innovation subject. It can be neither commanded nor planned, especially cannot be transferred to person's purpose in nature. This view expounds the nonmanagement characteristics of innovation subject. That is the inheritance and development of random innovation management.

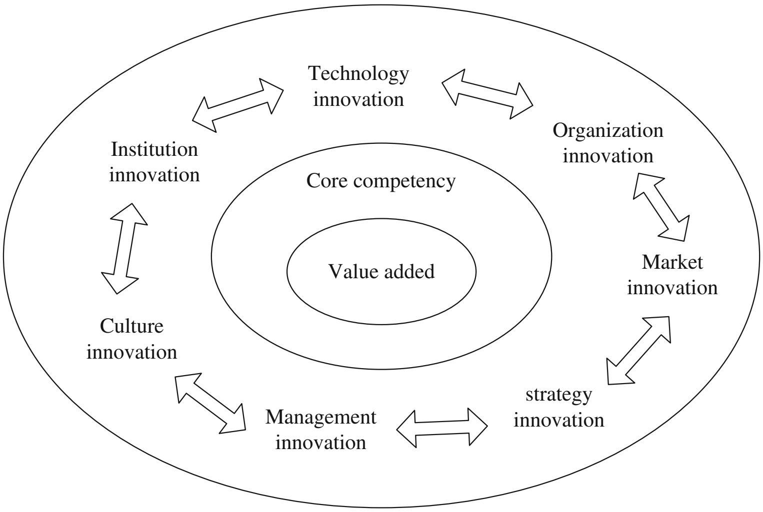

Fig. 176.1 The connotation of collaborative innovation management developed by the author based on reference (Xu 2007)

176.2.3 Collaborative Innovation Management

Collaborative innovation management is usually considered to construct a new frame. In this frame, all innovative elements and links can be coordinated in order to achieve the effective innovation. Professor Xu (2007) proposed the basic concept and idea of innovation management in his book. It meant to strive for the innovation of everyone, everything, every time and everywhere, taking value added as the goal, core competency enhancement as the center, the strategy as the guide, the collaborative innovation of each element (such as technology, organization, market, strategy, management, culture, institution etc.) as the method (See Fig. 176.1).

Liu et al. (2011), the Minister of Science and Technology Ministry of China, stated a similar connotation of innovation management with Professor Xu, and emphasized that the key point of innovation management was to expand and extend the scope of management, to build the innovation chain, and to put all units of innovation chain into management area. Innovation management needs to build a comprehensive platform to support innovative organization. The theory, method, tool, organization and structure collaborate with the whole process of innovation in this platform. In this case, each unit of the innovation interacts efficiently and each element in the innovation process is allocated rationally in order to achieve optimal results. Yang et al. (2003) also thought that innovation management was the platform to support the innovation in the organization (forming the system of innovative coordination), to increase the value and social welfare. Tidd (2001) raised technological innovation and nontechnological innovation of some excellent companies, involving all innovation elements. The companies pay special attention to the collaboration between technological innovation and non technological innovation.

176.3 Innovation Managmenet Classification

176.3.1 National Innovation Management

National innovation management is to realize the overall optimization of innovation system and society, to coordinate R&D (research and development) chain, industry chain and market chain to solve the market failures that may occur in the innovation system. Therefore, the enhancement of independent innovation of a country, is not enough only by the strength of the market mechanism (Kong 1990). At present, national innovation capability is the key indicator to determine the comprehensive strength of the nation. The government should focus on the regulation, integration, the building of public service platform, and establish the stable development of institutional mechanisms through improving the system, formulating effective policies and increasing investment on the research. Despite a strong research basement, it is difficult for some countries to gain a competitive advantage in global markets. Due to lack of scientific and technological strength, it is also difficult for some countries to maintain an existing competitive advantage. Only institutional mechanisms, which establish the efficient interaction among different innovation actors and the efficient joint among innovative elements, can ensure the innovation system to be effective and achieve the system goal of innovation-oriented country (D'Alvano and Hidalgo 2012).

176.3.2 Technological Innovation Management

Technological innovation management is an overall support for R&D, industry and market. Technological management must be considered from the view of short term and long term, supply and demand, traditional industry and emerging industry. This management should cover all aspects of innovation. Innovation competition expedites the mode revolution of science and technology management (Cantisani 2006). In the 21st century, R&D chain is greatly compressed. R&D links other aspects of innovation more closely and begins to depend on the market to a large extent (Hu et al. 2004). Under this situation, R&D independent management weakens relatively, whereas the management of innovation chain strengthens sharply. The socialization extent of innovation resource is enhanced significantly such as the basic condition of science and technology, fund, intellectual property and information etc. The engineering and integration trend becomes obvious in science and technology projects. The fluidity, internationalization and the team of scientific and technological personnel become prominent gradually. Therefore, it is necessary to require the technological innovation management to cover all links of the whole innovation chain.

176.3.3 Enterprise Innovation Management

Enterprise innovation management is to manage the innovation activities of enterprises. Enterprise manager plans, implements and controls innovation activities in order to enable innovation activities to be successful (Shu et al. 2012). From a manager point of view, the process of innovation is also a management process, and management process requires constant innovation. Therefore, it is necessary to divide the enterprise innovation process into three main stages: the intensification stage, the implementation stage and the diffusion stage. Management activities created by managers to meet the relevant conditions are different due to the different conditions in each stage during the process of business innovation. Different stages of management constitute a complete process of enterprise innovation management (Gong 2001).

176.4 Implement Methodologies and Tools for Innovation Management

Innovative management method is the key to realize innovation management based on theoretical research. The proper application of innovative method can improve the level of innovation management effectively. Liu et al. (2011) proposed the ten categories of tool for innovation management in accordance with the four-stage process of innovation activities. Hidalgo et al. (2008) summarized the methodologies and tools in accordance with the ten typologies of innovation management.

176.4.1 Ten Categories of Tools for Innovation Management

The general process of innovation activities include four stages: the discovery stage of innovation opportunity, the building stage of innovation platform, the implementation stage of innovation process and the assessment stage of innovation result. Figure 176.2 shows a systematic and universal tool set after the management tools of four stages are refined and reintegrated. Innovation management is a complex and dynamic management process. Successful innovation management makes the use of ten categories of tools to improve innovation activities efficiently. For example, the advantageous opportunity is seized by opportunity capture tool; the innovative resources are distributed optimally by resource allocation tool; innovative subjects choose the most appropriate objective in a complex environment by decision-making tool. Innovative management tools should not be used randomly. How to choose the tool and when to use the tool is extremely important for innovation management subject. When applying ten categories of tools for innovation management, the users select the proper time, rule and method to avoid copying mechanically or understanding tools partly.

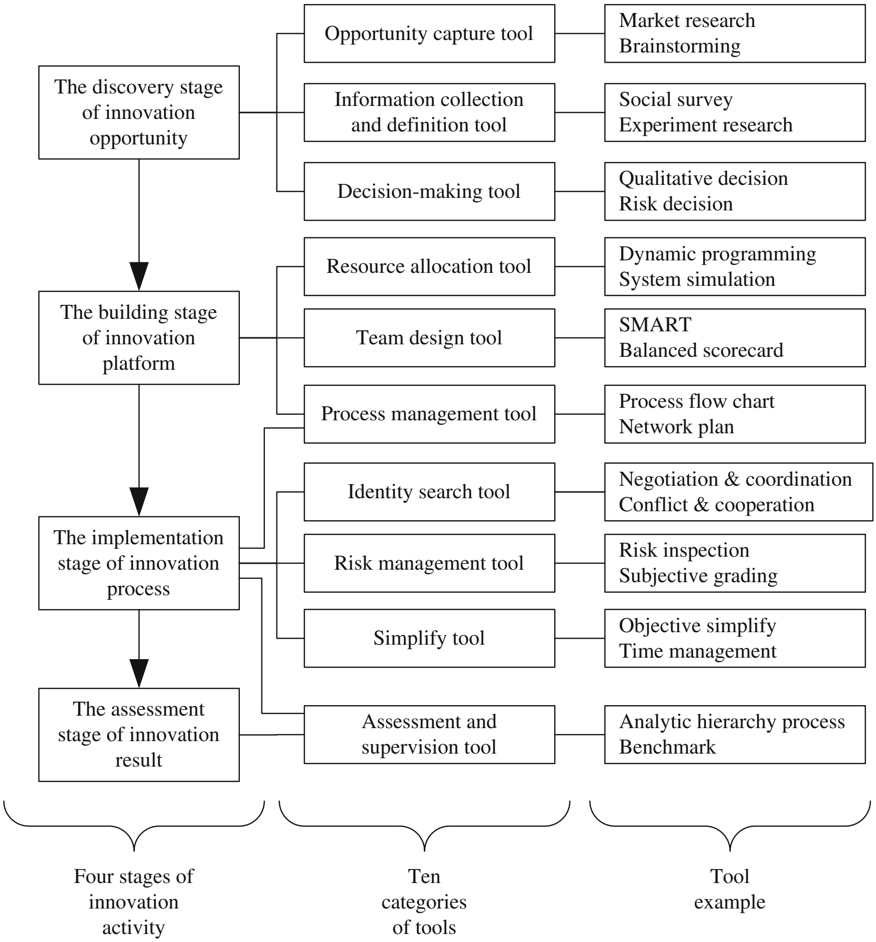

Fig. 176.2 Ten categories of tools for innovation management developed by the author based on reference (Liu et al. 2011)

Table 176.1 Ten typologies of tools for innovation management (Hidalgo and Albors 2008)

Ten typologies	Tool example
Knowledge management tools	Knowledge mapping
	Document management
Market intelligence techniques	Patents analysis
	Customer relationship management
Cooperative and networking tools	Team-building
	Supply chain management
Human resources management techniques	E-learning
	Competence management
Interface management approaches	Concurrent engineering
Creativity development techniques	Brainstorming
	TRIZ
Process improvement techniques	Benchmarking
	Workflow
	Just in time
Innovation project management techniques	Project appraisal
Design and project development management tools	Rapid prototyping
	Value analysis
Business creation tools	Business simulation

176.4.2 Ten Typologies of Innovation Management

Ten typologies of innovation management consist of knowledge management tools, market intelligence techniques, cooperation and networking tools, human resource techniques, interface management approaches, creativity development of techniques, processes improve techniques, innovation project management techniques, design and product development management tools and business creation tools. The tools, as shown in Table 176.1, are corresponding to ten typologies. There is no tool that can be one-to-one corresponding with the practical problems absolutely. One organization faces the challenges as a whole, and it is impossible to solve the problem by one innovative management tool in isolate. In the various environments, innovative management does not usually rely on one method to solve the problem, i.e. no single idealized mode. Therefore, innovative management tools in one typology cannot be used alone, in conjunction with other typologies of innovation management tools. Before the application of innovative management methods, it is necessary to clarify the objective of the organization and the standard, in order to make better use of innovative management methods.

176.5 Conclusion

Although innovation management has developed so far, there are also some problems in both foreign countries and China.

Firstly, the understanding of innovation management is not sufficient. Innovation management is a new management paradigm, essentially breaking the old balance. Not only product or process but also the organizational structure will be changed, which is bound to cause some strong resentment from employees or even managers. This phenomenon is also caused by the management characteristics of traditional organizations such as too much emphasis on program control, strict organizational hierarchy, the fixed way to exchanging information. This traditional organization structure prevents the enthusiasm and creativity of members seriously, moreover, it is difficult to adapt to dramatic changes in the modern environment. Innovation management, firstly, creates the idea and concept of the organization and forms the culture. According to the understanding of innovation, innovation management plays person's initiative fully and builds actively a good atmosphere to promote the occurrence of innovation. Human consciousness and behavior cannot dominate or control the occurrence of innovation, but can form the organizational mechanisms and cultural environment by the conscious innovation activities.

Secondly, innovation management talent is scarce. Innovation team is an initiative subject, the main power of implementing innovation. Team leader plays a key role in the team building. At the early stage of team form, it is impossible to form common goals and norms in the team due to the lack of mutual understanding among members. Team leader sets goals and assigns tasks for the team, so that the individuals compose an efficient team and co-ordinate their individual expertise or potential to achieve the good collaboration of the team. However, innovation management only focuses on the train of R&D talent for developing new products, and rarely focuses on the train of innovation management talent. Consequently, the talent and leader of innovative management are still scarce.

Thirdly, the system feature of innovative management is ignored. Innovation is a complex result of the interaction between different subjects and institutions. Innovation management cannot be finished only by some units of innovation chain. Technological revolution cannot emerge in a linear way, and it is the result of the interaction and feedback between the various elements within the system. The core of the system is the enterprise. The enterprise organizes the production and innovation and acquires external knowledge in the system. The main source of external knowledge is from other enterprises, public or private research institutions, universities and intermediary organizations. Therefore, enterprises, research institutions, universities and intermediary organizations are innovation subjects. For this reason, innovation management should gain the support from each organization to realize the innovation together.

In conclusion, innovation management as a new management style, cannot use the traditional management framework simply, that is a challenge for management theory and methods, or perhaps an opportunity for the development of management theory.

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Erratum to: Research on Factors Composition Model of Independent Innovation Capability for High-Tech Enterprises Based on Factor Analysis

Xiang-dong Li, Shu-qiang Wang, Ling Ma, Shu-cheng Luo and Shuo Wang

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The book was inadvertently published with an incorrect reference in Chap. 86, the correct reference is:

Andergassen R, Nardini F (2005) Endogenous innovation waves and economic growth. Struct Change Econ Dyn 16:522–539

The erratum book and the chapter has been updated.

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X. Li (✉) · S. Wang · L. Ma · S. Luo
School of Economics and Management, Hebei University of Technology, Tianjin, China
e-mail: lee96xd@163.com

S. Wang
e-mail: wsqxaf@126.com

L. Ma
e-mail: maling79@163.com

S. Luo
e-mail: lsc@hebut.edu.cn

S. Wang
Economic and Management Department, Nankai University Binhai College, Tianjin, China
e-mail: tarzen4@hotmail.com

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