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Proceedings of 20th International Conference on Industrial Engineering and Engineering Management

Theory and Apply of Industrial Management

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Preface

Being the sole national institution in the field of industrial engineering recognized by China Association of Science and Technology, Chinese Industrial Engineering Institution, CMES (CIEI), affiliated to the Management School of Tianjin University, was established in June 1990. Along with the development of CIEI, the research on industrial engineering is promoted on a large scale.

Adhering to the policy of "letting a hundred flowers blossom and a hundred schools of thought contend", CIEI takes its mission to build an international academic and business exchange platform in regard to industrial engineering or other related fields, and pursues fully developing democracy and free discussion on learning. Now CIEI grows into more than 20 local Institution of Industrial Engineering, possessing over 6,000 individual members and 136 corporate members, and it has established a cooperative relationship with the United States, Britain, Russia, Japan, Korea, Hong Kong, Taiwan and other countries or areas. An enormous number of experts, scholars and sub-societies from USA, England, Russia, Japan, Korea, Hong Kong, Macao and cross-Strait are attracted to attend its typical Academic Activities of The International Conference on Industrial Engineering and Engineering Management. The international academic conference is held annually; till now it has been held for 19 times with significant research results in theoretical and practical application.

The 20th International Conference on Industrial Engineering and Engineering Management (IEEM 2013) is sponsored by CIEI and organized by Inner Mongolia University of Science and Technology. Held in Baotou, one of the ten civilized cities in China, the academic conference aims to serve as a platform to share and discuss the latest researches about Industrial Engineering and Engineering Management, theoretically and practically, for experts, scholars, entrepreneurs, and industrial engineering practitioners from home and abroad. Some authorized experts from USA, Japan, India, and Hong Kong have been invited as Keynote Speakers to address their presentation. Additionally, some parallel sessions are set up for the authors to share their ideas or achievements in Industrial Engineering discipline. We hope the conference attendance could make a full use of the opportunity to learn, to exchange, and to promote the development of Industrial Engineering.

Finally, we would like to extend my sincerest thanks to Inner Mongolia University of Science and Technology for holding such an excellent event.

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Tianjin, People's Republic of China
August 2013

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Contents

Part I
Industrial Engineering – Systems Modeling and Simulation

Information Fusion Model Based on Multi-sensor Array and Its Anti-jamming Capability

Jiang Shen, Zhi-fang Liu, and Man Xu

Abstract For solving the problem of multi-information fusion of perceptual processes, the information perception based fusion model was built based on four behavior layers and bi-level optimization mechanism. The mean-variance normalization method was adopted to preprocess the data set with zero mean and unit variance. Electronic nose was applied for information processing in fire emergency management. The applications of this research increased the level of the system intelligence and its anti-jamming capability, and were parallel to the state-of-art technology in domestic level.

Keywords Anti-jamming capability • Information fusion • Multi-sensor array

1 Introduction

A category of complex systems characterized with heterogeneous, multi-dimensional multivariate structural characteristics, complex internal structure and behavior, high degree of open system, scale-free networks, systematic learning and adaptive features (Barabasi 2009; Yingluo Wang 2007), etc. Situational perception and information fusion technology was first introduced in military systems, and were widely applied in areas of aerospace (Wang 2008), intelligent medical solutions, industrial control (Zadeh 1972), supply chain management, financial engineering and other complex systems.

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1.1 Information Perception with Data Association

Information and knowledge in the system was mainly acquired with the process-aware information systems, data mining techniques and rough set method. Maslov and Gertner (2006) adopted a fuzzy algorithm with self-organizing capacity to obtain the multi-dimensional multivariate information of the complex system. Dong and He (2007) presented a Hidden semi-Markov model-based integrated system for acquiring multi-dimensional information on the probability event. Based on the process-aware information systems, Weber et al. (2008) proposed the ProCycle method to capture the dynamic information of the entire process life cycle. Leung et al. (2006) measured the incomplete certainty of the information system with Rough set, which was applied to mine useful knowledge in incomplete decision-making platform.

In the literature, several methods on multiple seamless information integration and data association were proposed, including probabilistic data association (PDA) (Neira and Tardos 2001), the multi-mode filter (Hong and Cui 2002) associated with interactions, joint probabilistic data association (JPDA) (Musicki and Evans 2004), extracting association rules from the interval data set (Winarko and Roddick 2007), Markov – Monte Carlo based data association (MMCDA) (Oh et al. 2009), etc. The state-of-the-art research results were common in military applications, for example, NNDA, PDA and JPDA were used to analyzed the information in environment of sparse target, high density and big data (Reshef et al. 2011).

1.2 Multi-sensor Networks

Centralized framework and distributed framework are the two common frameworks for multi-sensor networks. The distributed framework has obvious advantages than the other on the overall and real-time performance. However, information of the distributed sensor network was transmitted with a random delay in multi-sensor fusion system during the information gathering and processing periods, due to the limits of the bandwidth, node energy, dynamic network topology and routing protocols. To enhance the quality of data acquisition, scholars in Harvard University proposed an information fusion method for wireless sensor networks (Gaynor et al. 2004), which integrated wearable vital sign sensors and hand-held computers with specific common protocols and software framework, and developed the CodeBlue system (Lorincz et al. 2004) for wireless monitoring and tracking in medical first aid and emergency relief operations.

For the delay target tracking system based on two sensors, the optimal out-of-sequence measurement (OOSM) was presented to update artificial intelligence (AI) algorithm, such as the energy efficiency of large-scale sensor networks and its scalability was enhanced with the clustering method (Aslam et al. 2011). To obtain the optimal and high real-time tracking estimation, the use of noise solution related technology solved optimal recursive updating estimation for the multi-sensor step OOSM sensor target tracking system. However, applications of measurement based fusion method are extremely limited, due to the lack of information estimation accuracy, efficiency and real-time performance of the multi-sensor network-aware algorithm.

1.3 Efficiency and Robustness of Information Transmission

From the information theory point of view, the system characteristics of the information structure are multi-dimensional, dynamic and uncertainty for the information generated in the running process of the complex system (Xu et al. 2013). Furthermore, MIT scholars (Venkatesh and Dahleh 2001) studied the causes of the errors in the health care system from the perspectives of the information loss caused by outside interference in process of multitasking information transmission and by the high memory load due to multi-task interleaving in medical emergency. And the workflow analysis of the medical emergency department shows that multi-task conversion process is the key to the poor convergence of information flow. WANG Huan-chen (2006) studied the mechanisms of effective communication in the quality management of medical procedures through the distance of information transition.

Robustness co-exists with vulnerability of complex systems (Carlson and Doyle 2002), which is an important evaluation criteria of the system performance (Hazon and Kaminka 2008; Xu et al. 2012). Robust design of the system (Carlson and Doyle 2000) is a path to achieve robustness of the complex system. The current researches of this theory focus on the non-linear system control problem. Robust control theory is not only used in industrial control, but also has been widely used in many areas of economic control, social management, etc. Intelligent control (Luengo and Herrera 2010) is a c application-oriented combination technology of artificial intelligence, automatic control, operations research and information theory, which characterized with unstructured, uncertainty and autonomy and was capable of learning, adaptation and organizational functions (Franois et al. 2007). In United States, the researches on fault accident, human factors and human reliability, system reliability and the like problems were mainly for the applications of manufacturing systems, aerospace systems, nuclear reaction system (Baker et al. 2008), etc.

2 Data Processing for Multi-sensor Perception and Anti-jamming Capability

To reduce the impact of the interference signal to multi-sensor sensing information, a multi-sensor sensing data processing model (MSDP) was built. The probability density function of accurate perception was quasi-Gaussian processed with the statistically independent and state-independent clutter of Gaussian sensor. Multi-target prediction integral and multi-objective Bayesian normalization constant was calculated in closure form. The posterior distribution probability of multi-objective decision was constructed to decrease its errors with the fuzzy data.

To identify and process the multi-information in a unified framework, the multi-sensor information was pre-processed, including data filtering for this information, normalizating the uncertainty parameters of the perception data and its sub-space features, etc. The mean-variance normalization method and the non-linear function normalization method were commonly used as normalization methods.

The mean – variance normalization method was adopted to preprocess the data set with zero mean and unit variance. For the k-th feature of the data set with size of, the linear processing was executed by

$$v = \frac{1}{N}\sum_{i=1}^{N} \mathrm{v}_{ik'}, \quad k = 1, 2, \cdots, l$$

$$\sigma_k^2 = \frac{1}{N-1}\sum_{i=1}^{N} (\mathrm{v}_{ik'} - \overline{v}_k)^2$$

$$v_{ik} = \frac{\mathrm{v}_{ik'} - \overline{v}_k}{\sigma_k} \tag{1}$$

In addition to the linear method, non-linear methods were adopted to normalize the data which was unevenly distributed around the mean. Characteristic values were limited in the range of [0, 1] or [−1, 1] with appropriate ratios, namely, the data was mapped to the specified range with Nonlinear Function Transformation. Ratio is a generic method, which consists of two steps

$$V = \frac{v_{ik} - \overline{v}_k}{r\sigma_k}, \widehat{v}_{ik} = \frac{1}{1 + \exp(-V)} \tag{2}$$

When V is a small real number, the above equation can be regarded as an approximation of a linear function of v_{ik}, through a series expansion as an approximation. The linear region of the range depends on the standard deviation and the coefficient r. The data value is reduced exponentially when away from the mean.

Take the perceptual management system of fire emergency for example. In order to avoid the false alarm and the miss alarm of fire, the multi-sensor detection system composed of commonly-used fire sensors (thermal sensors, smoke sensors and differential/fixed temperature sensors) brings about the effective detection of the fire information. The information processing flow of the electronic nose application system of fire emergency is shown in Fig. 1.

The electronic nose system in the multiple sensor detection of fire linkage system is composed by Teflon pipes, two electro-magnetic valves, sensor units, pressure buffers, suction pumps, Interface cards(include CPU, A/D and D/A) and computers. After going into the electronic nose system, fire gases are transferred to the sensor

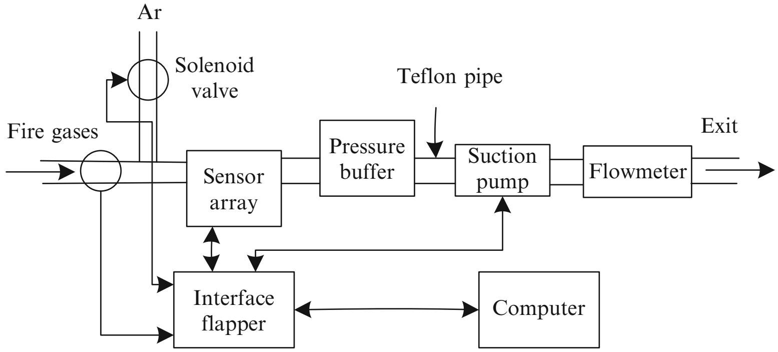

Fig. 1 Electronic nose was applied for information processing in fire emergency management

array and processed by the pressure stamping. After the connection of Teflon pipes, interface cards control the suction pump and adjust the gas output of the flow meter. Intelligent fire photoelectric smoke sensor can detect the smoke concentration in the fire environment through scatter infrared theory. And fire alarm signal is issued when the concentration exceeds the set threshold.

3 Information Perception Based Fusion Model and Optimization

To solve the problem of multi-information fusion of perceptual processes, the information perception based fusion model was built based on four behavior layers and bi-level optimization as shown in Fig. 2.

The four pivotal behavior layers are as follows: building the information fusion model for multi-sensor array and control data base, building the robust threshold based CBR/RBR information fusion model, modeling the composite overlay of the reasoning process with random terms, and establishing the reasoning confidence judgment and strategy optimization algorithm. The bi-level optimization mechanism consisted of D-S fusion based evidence confidence optimization and information perception based decision strategy optimization.

Layer 1: Access to the multi-dimensional signal source which is perceived through complex systems information perception of integration mechanism and model. Use the state space represent these multi-task sensor perception heterogeneous information and determine multi-objective planning constraints and objective function. Completing letter filtering model processing, information fusion of multi-sensor array can be realized by using Bayesian tracking to identify the target and normalization coefficient table.

Layer 2: In order to improve CBR/RBR-based information fusion efficiency, multiple heterogeneous information data base needs to refine the core attributes and the

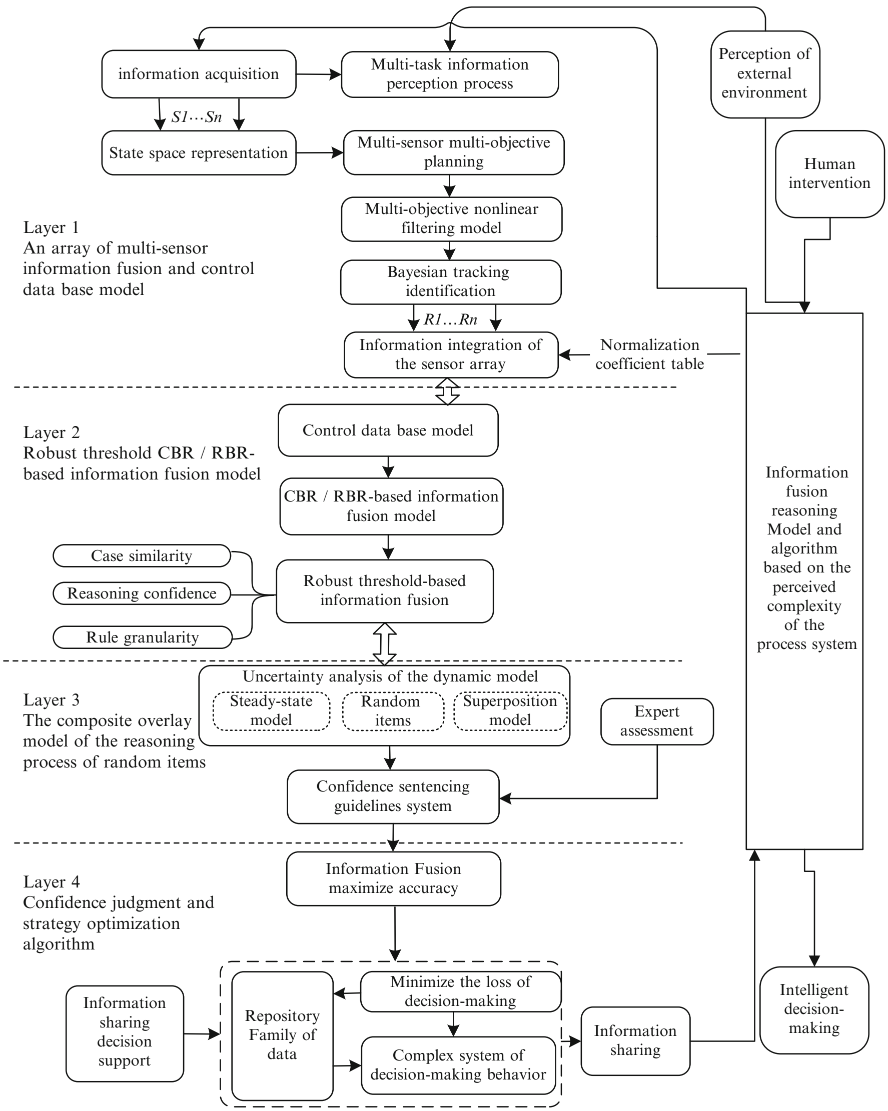

Fig. 2 Information perception based fusion mechanism and its model of the complex system

elimination of redundant data sets. Eigenvalues and refined information fusion space, constitute a case similarity rule confidence posed by robust threshold criteria of information fusion.

Layer 3: Build the superposition model based on the CBR/RBR information fusion steady-state model and the consideration of the uncertainties of information perception as well as the use of quantitative analysis of the randomness. Sentencing guidelines expert assessment, confidence building dynamic information fusion system.

Layer 4: Embodied criteria based on information fusion, decision-making behavior and operation of complex systems to optimize the combination of massive data repository and a sensor family of data by means of reasoning and sharing, increase the use of information value in the case of human disturbance to enhance the level of intelligence of the system of decision-making.

4 Discussion and Conclusion

The theoretical model of information perception, its control method and information fusion mechanism were studied for the operation of complex systems. The state space of the information perception and the structural characteristics of the information chain were analyzed to reveal the information perceived status and the mapping rules of complex systems. The robust threshold based fusion model and algorithm was proposed for the process of the information perception and information transmission, completing the task of system identification of valid information perception and fusion. Multi-layer behavioral process on the dynamic data was refined to enhance the anti-interference capability and the performance of intelligent decision-making based on the parameter management of multi-sensor perception.

Three typical applications were conducted mainly based on these calculation model, the control system and application platform, including upgrading the intelligent medical diagnostic system and the embedded systems of its intelligent network system for clinical teaching, providing the network system for intelligent diagnosis of heart disease and its occupational training of emergency control; and achieving the transformation of the Tianjin city fire emergency decision support system and fire protection management; and contributing to the construction of intelligent control systems of green campus of Tianjin university, which upgraded the existing system and reduced the maintenance and operating costs, increased the level of the system intelligence and its intensification, and was parallel to the state-of-art technology in domestic level. Therefore, the results of this research have high promotion values, broad application prospects and sustainable economic and potential social benefits.

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Analyzing Dynamic Capabilities from the Routine-Based Perspective: An Agent-Based Simulation Research

De-hua Gao, Xiu-quan Deng, Shao-long Kuang, Shun-tang Zhang, and Bing Bai

Abstract For dealing with the complexity and dynamics inherited in dynamic capabilities area, we try to introduce the agent-based simulation method into our study. By taking operating routines as basic units of analysis, a micro- interpretation of dynamic capabilities is given from the routine-based perspective. The relationships among operating routines, dynamic capabilities as well as organizational learning mechanisms – including both internal innovation and external imitation activities are discussed in detail. And an agent-based simulation model is provided via Swarm package. The results show that: agent-based simulation can be used as one of effective tools in coping with dynamic capabilities problems.

Keywords Agent-based simulation • Dynamic capabilities • Imitation • Innovation • Operating routines • Organizational learning

1 Introduction

According to Teece et al. (1997), dynamic capabilities is defined as the firm's abilities "to integrate, build, and reconfigure internal and external competences to address rapidly changing environments" (Teece et al. 1997). It is in fact some

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learned and stable patterns of collective activities through which the organization systematically generates and modifies its operating routines in pursuit of improved effectiveness (Nelson and Winter 1982; Zollo and Winter 2002; Winter 2003). Here, the "learning" behavior can be considered as a routine-based activity (Zollo and Winter 2002; Saka-Helmhout 2010) that consists of two aspects, i.e., the internal innovation activities of the firm itself (e.g., product developing routines in (Rothaermel and Hess 2007; Chen and Jaw 2009)) and coordination activities from the outside (e.g., alliances in (Wever et al. 2005)).

In this paper, we take routines as units of analysis, and introduce the agent-based simulation method into our study. The structure of the paper is as follows: Sect. 2 analyzes the micro-foundations of dynamic capabilities from a routine-based perspective; Sect. 2 investigates some factors that impact dynamic capabilities through reinforcements and changes of or changes in routines; Sect. 3 builds up an agent-based simulation model for the problem and gives the results and discussions; and Sect. 4 are the conclusions.

2 Theoretical Foundations

2.1 Routines as Units of Analysis

The term "routines" refers to "skills of an organization" and "repetitive patterns" of organizational activities (Nelson and Winter 1982). They are critical components of organizational behaviors that play an important role in understanding how firms and the economy work, and hold one of the keys for understanding how organizational capabilities are accumulated, transferred and applied (Becker 2004; Pentland and Feldman 2005; Becker et al. 2005).

From a routine-based perspective, the organizational capabilities can be mainly divided into two levels, i.e. the "0-order" capabilities and the "high-order" capabilities (Collis 1994), which Winter (2003) called as operational capabilities and dynamic capabilities separately. The former – i.e., the operational capabilities – are indeed some various sets of operating routines. With the organizational managers' decision choices, they transform inputs (resources) into special types of outputs (Nelson and Winter 1982; Winter 2003). While the later – i.e., the dynamic capabilities – are the abilities to build, integrate and reconfigure these operational capabilities (operating routines) (Teece et al. 1997). They can be seen here as some rules of modification of operating routines that enable high-adaptive behavior (Galunic and Eisenhardt 2001). That is, dynamic capabilities are indeed the organizational and strategic "routines" by which the firm generates and modifies its operating routines and achieve some "new source configurations as markets emerge, collide, spit, evolve, and die" (Zollo and Winter 2002; Eisenhardt and Martin 2000). They govern the rate of changes of the operating routines and influence the firm's outputs indirectly via the operational capabilities (Nelson and Winter 1982; Winter 2003; Collis 1994; Abell et al. 2008).

We suppose that there are l operating routines $R = (r_1, r_2, \cdots r_l)^T$ for a firm A, and each routine consist of s_i programs $r_i = (q_1, q_2, \cdots, q_{s_i})^T$. Operational capabilities of the firm – i.e., the routines R – are in fact collections of all of the programs that managers should conform to during their decision making processes, $R = (q_1, q_2, \cdots, q_{s_1}, q_{s_1+1}, q_{s_1+2}, \cdots, q_{s_i})^T$. Thus, the genotype of this firm can be denoted as:

$$GT = (g_1, g_2, \cdots, g_m)^T \tag{1}$$

Where m in the vector GT represents the total number of programs existed in the firm, and the element g_j represents the program j, $g_j \in R$ ($j = 1, 2, \ldots, m$).

2.2 The Measurement of Dynamic Capabilities

In order to evaluate the performance of dynamic capabilities, Helfat et al. (2007) proposed the concept "evolutionary fitness" from the resource-based view referring to how well a dynamic capability enables a firm to "make a living by creating, extending or modifying its resource base (sets of routines)" (Helfat et al. 2007). When measuring dynamic capabilities, there are two sides that should be considered– i.e., the "dynamic" characteristics of the environments' side – denoted as the preferences of customers PC – and the "capabilities" side of the firms to generate and modify their operating routines – denoted as the improvements of the phenotype of the organization PT (Hodgson 2003). We suppose that there are n elements included in the vector PC as well as the vector PT, and let:

$$PC = (c_1, c_2, \cdots, c_n)^T \tag{2}$$

$$PT = (p_1, p_2, \cdots, p_n)^T \tag{3}$$

While,

$$PT = GT^T \cdot TM \tag{4}$$

Where, the function TM represents a genotype-phenotype map (Ma and Nakamori 2005), i.e., a transfer matrix of the firm, which transfers the genotype GT into the phenotype PT.

$$TM = \begin{pmatrix} t_{11} & t_{12} & \cdots & t_{1n} \\ t_{21} & t_{22} & \cdots & t_{2n} \\ \vdots & \vdots & \ddots & \vdots \\ t_{m1} & t_{m2} & \cdots & t_{mn} \end{pmatrix}$$

And we have the fitness value *Fit* as that:

$$Fit = PC^T \cdot PT = (c_1, c_2, \cdots, c_n) \cdot (p_1, p_2, \cdots, p_n)^T \tag{5}$$

2.3 Organizational Learning and the Evolution of Dynamic Capabilities

Dynamic capabilities that constitute the firm's systematic methods for modifying operating routines arise from organizational learning (Zollo and Winter 2002; Ambrosini et al. 2009). Eisenhardt and Martin (2000) pointed that for the high-velocity markets especially, it is the "well-known learning mechanisms" that guide the evolution of dynamic capabilities (Eisenhardt and Martin 2000; Zott 2003). So, we can regard organizational learning mechanisms as some of the "second-order" dynamic capabilities (Zollo and Winter 2002; Collis 1994), i.e., the "routines" by which the firm generates and modifies its dynamic capabilities – and ultimately, changes operational capabilities (the operating routines). That is, they "shape operating routines directly as well as by the intermediate step of dynamic capabilities", while the operating routines are indeed "the outcome of trial-and-error learning and the selection and retention of past behaviors" (Zollo and Winter 2002; Gavetti and Levinthal 2000).

Here, we adopt the "variation–selection–retention (VSR)" model in accordance with the Darwin's classic evolutionary theory to represent the evolutionary algorithm of genotypes *GT* among all of the firms in our study as follows (Nelson and Winter 1982; Zollo and Winter 2002; Aldrich and Ruef 2006):

Variation: In the first stage, the firm gets changes from current operating routines intentionally and/or blindly, formulating some alternatives for its new genotype.

Selection: Variations help the firm acquire much more possibilities for choices. And in this second stage, the firm should evaluate its multiple alternatives and identify a preferred one. For example, it can pick out from many of its alternative genotypes the fittest one – the one with the highest value of the fitness parameter *Fit*.

Retention: Finally, the firm decides whether or not to retain and implement its "new genotype" obtained from the "selection" stage actually. In this stage, the firm may accumulate its experiences by holding operating routines repetitively.

2.4 Internal Innovation or External Imitation

The variation stage mentioned above can be realized through internal innovation and external imitation activities, *etc.* (Zott 2003; Aldrich and Ruef 2006). Both of these two kinds of activities consist of the key parts of the variation process and form the basis of the firm's learning mechanisms, and they cause changes of the operating routines, and as a result, modify the genotype *GT* of the firm.

However, the differences between them are that: the internal innovation activities mainly refer to "internally focused search", while the external imitation activities refer to "externally focused search" (Zott 2003). That is, by internal innovation, the firm generates or modifies routines itself, while by external imitation, it accomplishes these through learning from others.

In our model, we denote these two kinds of activities as follows:

Firstly, for internal innovation, the firm chooses an operating routine and changes some of its programs randomly, i.e., gives a certain increment Δg_i to the element g_i of the genotype vector *GT* (i = 1, 2, *m*).

Secondly, for external imitation, the firm should firstly searches for another firm that performs better, and then chooses a routine randomly and replaces some of its programs by those of the target firm, i.e., substitutes a g_i^* (from another genotype vector *GT**) for the element g_i of the genotype vector *GT* ($i = 1, 2, \ldots, m$).

3 An Agent-Based Simulation of Dynamic Capabilities

3.1 Design of the Agent-Based Simulation Model

Our simulation model is mainly composed of two types of agents:

Firms: Firms are agents with certain genotypes as some of their important attributes. These firms are connected with some others as their neighborhood. At each simulation tick, they can variate their own genotypes through internal innovation and/or external imitation activities, and compute the average of their customer perceived values from their potential customers as their fitness values. And the variation of the genotypes – i.e., variation of their operating routines – may cause the evolution of their dynamic capabilities, and as a result, influences their performances.

Customers: Customers are some other types of agents with different preference parameters. They are linked with some firms as their alternative suppliers. At each simulation tick, they evaluate their perceived values about their alternative suppliers; choose the firm with the highest perceived value, and do transactions with it one unit product each time.

For simplification, we hypothesize that:

1. Both firms and customers are living in some specific space "defined as a social network" (Lamieri 2006). That is, each firm owns a certain number of firms as its neighborhood (partners for organizational learning), *ffRelationNum*; and each customer owns a certain number of firms as its alternative suppliers, *cfRelationNum*. Besides, there are three types of relationships, namely, the customer-firm linkages, the firm-firm linkages and the customer-customer linkages. Here, we only consider the dynamics of the customer-firm linkages, suppose the firm-firm linkages to be fixed during the simulation process, and ignore the customer-customer linkages – i.e., customers do their transaction behaviors separately, but not have influences with each other.
2. The dynamics of the customer-firm linkages can be depicted as that: at each simulation tick, the existing edges that represent customer-firm linkages are destroyed, and some of other new edges are created randomly with a given probability *cfUpdateProbability*.
3. The internal innovation and external imitation activities of firms are succeed with the given probability parameter *innovProbability* and *imitaProbability*, respectively. And the costs of these activities are treated as some negative effects of their fitness values during the computation processes.
4. The elements values of the transfer matrix *TM* of a firm are 0–1 ones, which are determined by a given probability *oneProbability*. That is, let *rnd* be a random number subject to a uniform distribution *U* (0, 1), we have that:

$$t_{ij} = \begin{cases} 1, \text{if } rnd \leq oneProbability \\ 0, \text{otherwise} \end{cases} \quad (i = 1, 2 \ldots m;\ j = 1, 2 \ldots n) \tag{6}$$

5. We use the total sales of a firm simply as a parameter to represent its performances.

3.2 Simulation Results and Discussion

In this section, we realize agent-based simulation model via the Swarm package (Swarm Development Group (SDG) 2000), and adopt the unit testing method discussed in (North and Macal 2007) for verification of the program. With a given scenario below:

The firm number $firmNum = 9$;
The customer number $customerNum = 500$;
The neighborhood firms' number of a firm $2 \leq ffRelationNum \leq 5$;
The alternative suppliers' number of a customer $5 \leq cfRelationNum \leq 7$;
The customer-firm network updating probability $cfUpdateProbability = 0.05$;

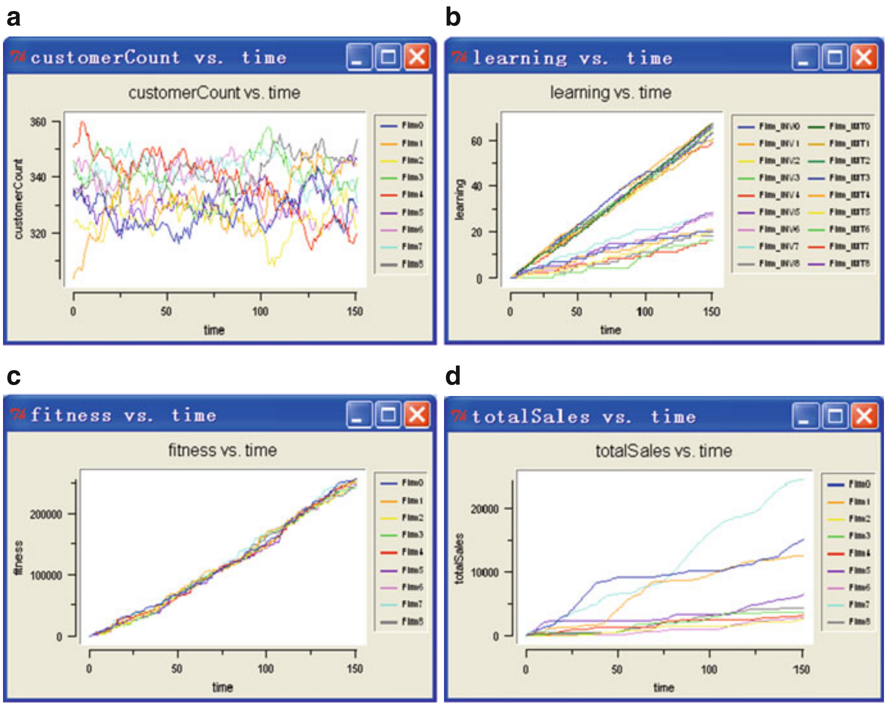

Fig. 1 The simulation results of a given scenario. (**a**) Alternative customer numbers of firms. (**b**) Learning (innovation and imitation) times. (**c**) Fitness values of firms. (**d**) Total sales of firms

The success probability of innovation activities *innovProbability* = 0.3;
The success probability of imitation activities *imitaProbability* = 0.9;
The genotype length *genoTypeLength* = 9;
And the phenotype length *phenoTypeLength* = 12.

We execute a simulation with 150 ticks, and get the results as shown in Fig. 1.

Firstly, the alternative customer numbers of firms changes randomly with time because of the environmental dynamics. As shown in Fig. 1a.

Secondly, the organizational learning processes lead to variations of the genotypes of firms – i.e., the operating routines – through internal innovation and/or external imitation activities, which then have impacts on dynamic capabilities – e.g., improve the fitness values – of firms indirectly. As shown in Fig. 1b, c.

Thirdly, there are positive correlations between organizational learning and dynamic capabilities. Take the simulation results in Fig. 1b, c for example, firm 7 has a higher internal innovation capability, and thus gains a higher fitness value; while firm 0 with a higher external imitation capability but a lower internal innovation capability also achieves a higher fitness value.

And forth, there are not direct relationships between capabilities and the firm performances. Just as Eisenhardt and Martin (2000) pinpointed that dynamic capabilities are only “necessary, but not sufficient, conditions” for competitive advantage (Eisenhardt and Martin 2000), we can see from Fig. 1c, d that: firms with higher fitness values may be, but not always, owning higher total sales in a given period– e.g., firm 1 with the highest fitness value has a rapid growth of total sale during the simulation tick between 45 and 55, but its performance (the total sale account) still less than firm 0 and 7.

Then, for investigating the impacts of organizational learning (internal innovation and/or external imitation activities) as well as the environmental dynamics (the network structure) to operating routines, and thus to dynamic capabilities, we execute the simulation at various different combinations of input parameters, and obtain the results as shown in Fig. 2.

In a moderately dynamic market (*cfUpdateProbability* = 0.05), external imitation can improve the firm’s dynamic capabilities significantly. As shown in Fig. 2a, it is firm 0 with a higher external imitation capability that gains a higher fitness value, and as a result, a higher performance – e.g., a higher total sales quantity. However, it is the imitation that may lead to the diffusion of optimal genotypes among the network, and thus causes some of the firms losing their competitive advantages. On the other hand, while in a high-velocity market (*cfUpdateProbability* = 0.85), internal innovation is critical to the evolution of dynamic capabilities. Through innovation activities, firms can generate some newly genotypes with core competences. As shown in Fig. 2f, take firm 7 for example, a much higher internal innovation capabilities can result in a higher level of dynamic capabilities, and thus, lead to a higher performance.

4 Conclusions

From a routine-based perspective, we take the operating routine as a basic unit of analysis, and depict a micro-interpretation of dynamic capabilities. By considering the linkages between operating routines, dynamic capabilities, and organizational learning (including both internal innovation and external imitation activities), we put forward an agent-based simulation model via Swarm package. We conclude that: Firstly, as the basic units of analysis, operating routines build up the foundation of dynamic capabilities. Secondly, organizational learning plays an important role during the evolution of dynamic capabilities. It determines the evolutionary mechanisms of operating routines, and thus shapes the evolutionary trajectories of dynamic capabilities. And thirdly, network structure plays an important role during the evolution of dynamic capabilities via its influences on organizational learning activities.

The contributions of our work are that:

1. We investigate dynamic capabilities from a routine-based perspective, and discussed the relationships among operating routines, dynamic capabilities and organizational learning as well.

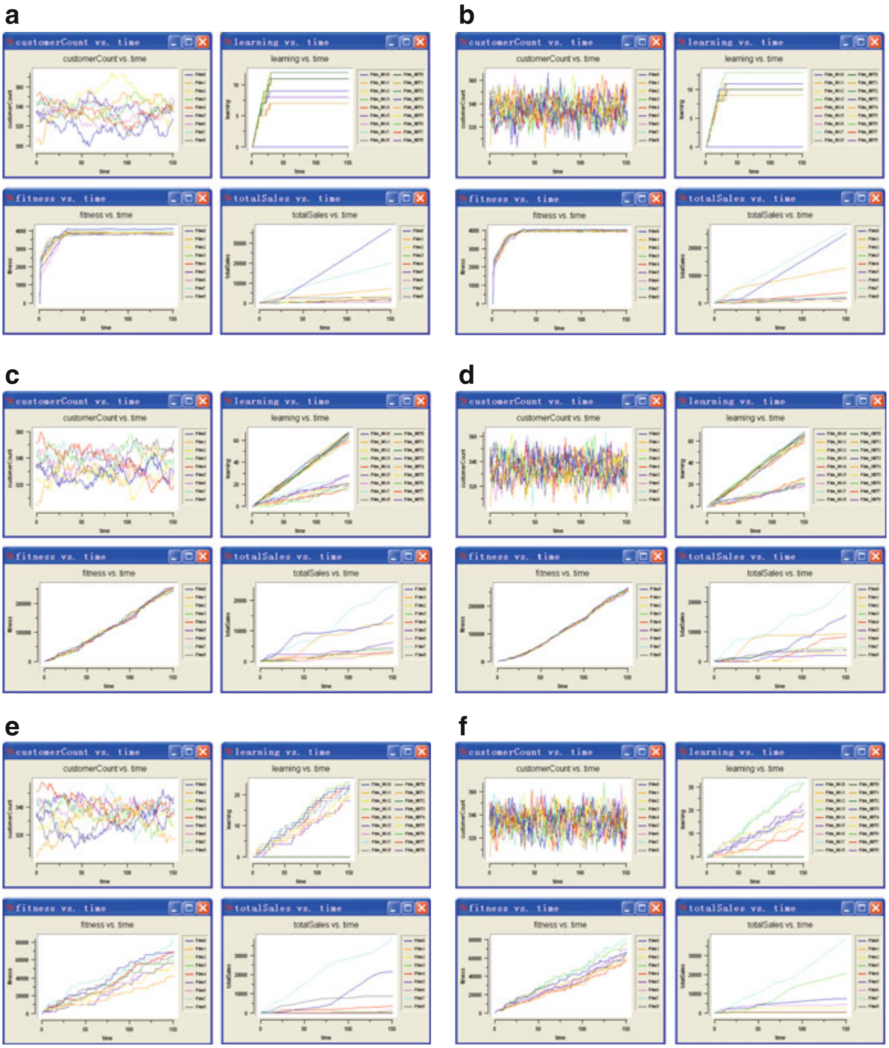

Fig. 2 Comparing the simulation results of different scenarios. (**a**) *innovProbability* = 0 *immitaProbability* = 0.9 *cfUpdateProbability* = 0.05. (**b**) *innovProbability* = 0 *immitaProbability*= 0.9 *cfUpdateProbability* = 0.85. (**c**) *innovProbability* = 0.3 *immitaProbability* = 0.9 *cfUpdateProbability* = 0.05. (**d**) *innovProbability* = 0.3 *immitaProbability* = 0.9 *cfUpdateProbability* = 0.85. (**e**) *innovProbability* = 0.3 *immitaProbability* = 0 *cfUpdateProbability* = 0.05. (**f**) *innovProbability* = 0.3 *immitaProbability* = 0 *cfUpdateProbability* = 0.85

2. Via the computer tools, we try to introduce the agent-based simulation method into the analysis of dynamic capabilities problems. From the agent-based simulation model of dynamic capabilities, we can develop experimental simulation researches conveniently, manage and design operating routines as well as

dynamical capabilities through a much more effective approach. And these, may shed some light on studying complex and dynamic social phenomena through artificial experiments.

However, there are still some further problems to solve, such as the details of organizational learning impacts on dynamic capabilities and operating routines, the inter-relationships between dynamic capabilities and firm performances, and so forth. Besides, we should also expand the model to compassing more modules like the information base and knowledge management, *etc*. All of these may hint some directions of our future work.

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Valuation of Sustainable Development in Mudanjiang City Based on the Method of Genuine Saving

Ying Zhang and Hai-xin Huang

Abstract Scientific development concept is important for China now. How to measure the sustainable development extent of a specific area is a question we should pay most attention to. Genuine saving is one of the most nature methods based on green GDP. After collecting data we need in different ways, we calculate the genuine saving in Mudanjiang. With the analysis, we draw a conclusion that the genuine saving rate of Mudanjiang is higher, so far not negative. But there is a trend of gradual decline in recent years.

Keywords Genuine saving • Mudanjiang • Sustainable development

1 The Present Situation of Sustainable Development Theories and Measurement Methods

Sustainable development is a new mode of development proposed by mankind after summarizes its development process. To sum up, the measurement methods roughly include the following three kinds:

The sustainable development index system established on the basis of the ecological perspective. Most of this kind of indexes is based on the theory of environmental carrying capacity, such as the "ecological footprint" (EF) proposed by Wackernagel, "net primary productivity (NPP)" and "Environmental space"

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proposed by Vitousek. Moreover, the energy value analysis method to evaluate the impact of a regional and national sustainable development, such as ECCO model (Zhang and Wen 2003).

The composite indexes of sustainable development established on basis of the value accounting. Using the method of Economics, the index measures depletion of natural resources and environmental loss caused by the stock of natural resources and human activities through evaluation and applying the economic cost benefits analysis methods evaluates the effects of human activities and consolidates these effects into a comprehensive development index on currency unit (World Bank 1995). This kind of index thus is called monetary indicators of sustainable development.

2 The Basic Principle of Genuine Saving

Genuine saving is an index which broadly measures the national wealth. It is the savings rate taking a country's natural resources depletion and environmental pollution damages into consideration (Ye 1997). Genuine saving comes directly from the general savings concept in macro-economic analysis. Initially, the World Bank applied the indicator to measuring a country's national wealth and economic development status and potential, but the practice proves that the method is applicable in the city's measurement.

Genuine saving acts a link which ties directly the different functions of resources, environment, finance, planning and others. Its policy implications are that the continued negative genuine saving will eventually to a decline in social welfare, which reflects the unsustainability of the existing policy. In addition, another factor that influences the genuine saving scale of a country of a region is the value of the natural resources depletion, which shows that if the resources were utilized and managed reasonably, the sustainable revenue stream of city would increase (Bolund and Hunhannar 1999). Therefore, the policy issue we face is that how to utilize and conserve the natural resources reasonably and effectively.

3 The Calculation of Genuine Saving

Calculation program is shown in Table 1. This method counts the environmental externalities of economic activity itself and the loss of natural capital which excluded in the GDP. It can reflect the relationship between the genuine savings and GDP and policy implication (Ton et al. 1998).

Table 1 The calculation of genuine saving

Economic indicators	Economic indicator code and mathematical relationship	Economic indicators	Economic indicator code and mathematical relationship
GDP	(1)	Depreciation of fixed assets	(10)
Total consumption	(2)	Net saving	(11) = (9) − (10)
The exports of goods and services	(3)	Depletion of natural resources	(12)
Total Effective domestic investment	(4) = Effective investment coefficient × [(1) − (2) − (3)]	Genuine savings	(13) = (11) − (12)
Regular education investment	(5)	Extraterritorial effects of CO_2	(14)
Generalized total domestic investment	(6) = (4) + (5)	he upper limit of pollution losses	(15)
Foreign borrowing	(7)	The lower limit of pollution losses	(16)
Foreign borrowing	(8) = (7) × Exchange rate	Genuine saving$_{21}$	(17) = (11) − (12) − (14) − (15)
Total saving	(9) = (6) − (8)	Genuine saving$_{22}$	(17) = (11) − (12) − (14) − (16)

Note: (1), (2), (3), (7), (10) come from the years of city statistical yearbook, (5) come from the City Board of education, (12), (14), (15), (16) come from calculation

4 Data Collection and Calculation

4.1 Mudanjiang Overview

Mudanjiang city is located in the southeast of Heilongjiang Province. It riches in water resources, also it is one of three forest district in Heilongjiang. Coal is the main energy in Mudanjiang city. Due to the harsh geographical environment, poor weather condition, limited economic condition, pollution debts, the atmospheric environmental quality does not meet the grade two standard of national environment air quality.

4.2 Selected Indicators

When we select the index, in addition to the calculation of genuine savings necessary GDP, the total consumption of goods, services and import factor, we

Table 2 Mudanjiang 2005–2010 natural resources loss calculation results

Year	Forest volume (×10 m)	Value (million)	Cumulative loss area of farmland (million hectares)	Cumulative damage value (million)
2007	188	19,338	2	7.13
2008	192	22,854	3.5	12.47
2009	196	26,370	4	14.26
2010	206	35,160	4	14.26
2011	209	37,797	4	14.26
2012	212	40,434	5	17.82

Note: The area of cultivated land change to 2004 as the base, 170,000 ha 2004. The wetland area without access to data

must select resources and environment factor. In the selection process, we must consider comprehensively the natural and social conditions in Mudanjing city under the guidance of principles of comprehensive, leading, data accessibility, operability. In the aspect of the natural resources, we select the internationally recognized, environmental factors which have significant impact on the city's industrial production and people's lives and they are forest stock volume, selected area of wetland and farmland area. In the environmental loss, the selected indexes are SO_2 and soot, dust, water and noise pollution. Considering the extraterritorial effect of the environmental pollution, we must also select the CO_2 indicator. These data come from sources in Mudanjiang City Statistical Yearbook and conversion price factor derives from literature (Zhang and Wen 2003).

4.3 Calculation on Depletion of Natural Resources

According to the research results of the China Council for international cooperation on environment and Development, considering the value of timber, forest ecological benefit and environment factors. Calculation results are shown in Table 2.

4.4 Environmental Pollution Loss Estimation

In this paper, the loss of environmental pollution includes the loss of air pollution, water pollution and noise pollution. The loss calculation of air pollution, water pollution and noise pollution is based on the City Health Bureau and other research data of related departments. The cost price of pollutants is based on literature (World Bank 1995). Calculation results are shown in Tables 3 and 4.

Table 3 2005–2010 Mudanjiang city air pollution loss calculation results

Year	The GDP ratio of upper limit (%)	Upper limit (million)	The GDP ratio of lower limit (%)	Lower limit (million)
2007	3.97	69,028	1.74	31,691
2008	2.17	45,063	0.34	7,061
2009	3.47	79,321	0.41	9,372
2010	2.10	50,931	0	0
2011	2.03	55,634	0	0
2012	1.94	58,550	0	0

Table 4 Mudanjiang 2005–2010 water pollution, noise pollution loss calculation results

Year	Waste water emissions (million tons)	Water pollution loss lower limit (million)	Water pollution loss upper limit (million)	Noise pollution loss value (million)
2007	8,327	13,114	127,675	200
2008	8,799	13,913	132,489	187
2009	9,306	18,516	165,042	137
2010	9,172	17,705	171,953	170
2011	9,093	21,651	195,403	137
2012	9,133	21,730	211,867	151

Note: Here we adopt results reference method and convert Dalian's city noise pollution loss

4.5 Calculation Results and Analysis of Mudanjiang City's Genuine Savings

According to the calculation results of loss caused by the depletion of natural resources and pollution and above calculation process of genuine savings, we can get the value of genuine savings and other related indexes. The using data and calculation results are shown in Table 5:

From the Fig. 1, we can draw that the genuine savings rate of Mudanjiang is higher, so far not negative. But there is a trend of gradual decline in recent years. One of important causes of Mudanjiang city's higher savings is that the total social consumption growth rate is lower than the growth of GDP in recent years, while the total investment is higher. This fact suggests that the economic revenues of the residents in Mudanjiang city have been improved obviously, but the resources and environment foundation on which the people dependent are destroyed, physical health is damaged and the material conditions of long-term social development was destroyed to some extent. Especially the lower limit of genuine savings in GDP has reached 4.1 % in 2009. Mudanjiang city is now still in the state of sustainable development, but it more likely transformed into the unsustainable state. At the same time, its foreign debt is accumulating, while the non-renewable energy consumption is increasing. As an open city, chemical industry occupying an important position,

Table 5 The calculation process and results of Mudanjiang genuine saving rate (Unit: 10,000 Yuan)

Year	2007	2008	2009	2010	2011	2012
GDP(current prices)	1,821,328	2,076,635	2,285,904	2,425,292	2,740,580	3,018,052
Total consumption	726,720	798,665	922,574	1,004,683	1,001,132	1,239,875
Savings	1,094,598	1,277,970	1,363,330	1,420,609	1,639,448	1,778,177
Services and cargo net export	110,328	126,372	161,055	186,663	216,342	251,174
Total investment	488,993	515,398	521,082	590,371	612,623	79,982
Investment in education	35,936	47,257	56,047	84,036	99,832	107,736
Generalized gross domestic investment	524,929	562,655	577,129	674,407	712,455	787,718
Cumulative total external debt	1,914	1,825	1,500	1,397	1,108	1,124
Total savings	523,015	560,830	575,629	673,010	711,347	786,594
Depreciation of fixed assets	107,024	139,864	183,093	206,101	217,478	231,511
Net savings	415,991	420,906	392,536	466,909	493,869	555,083
Total resource consumption	19,395.13	22,866.47	26,384.26	35,174.26	37,811.26	40,451.82
Genuine savings 1	396,595.8	398,099.5	366,151.7	431,734.7	456,057.7	514,631.1
Air pollution loss lower limit	31,691	7,061	9,372	0	0	0
Air pollution loss upper limit	69,028	45,063	79,321	50,931	55,634	58,550
Water pollution loss lower limit	13,114	13,913	18,516	17,705	21,651	21,730
Water pollution loss upper limit	127,675	132,489	165,042	171,953	195,403	211,867
Noise pollution loss value	200	187	142	121	106	110
Genuine savings$_{21}$ (upper)	351,590.9	376,938.9	338,121.7	413,908.7	434,300.7	492,791.1
Genuine savings$_{21}$/GDP	11.3 %	18.2 %	14.8 %	17.1 %	15.8 %	16.3 %
Genuine savings$_{22}$ (lower)	154,687.9	199,199.5	93,616.7	190,903.7	183,157.7	222,264.1
Genuine savings$_{22}$ (lower)/GDP	8.5 %	9.6 %	4.1 %	7.9 %	6.7 %	7.4 %

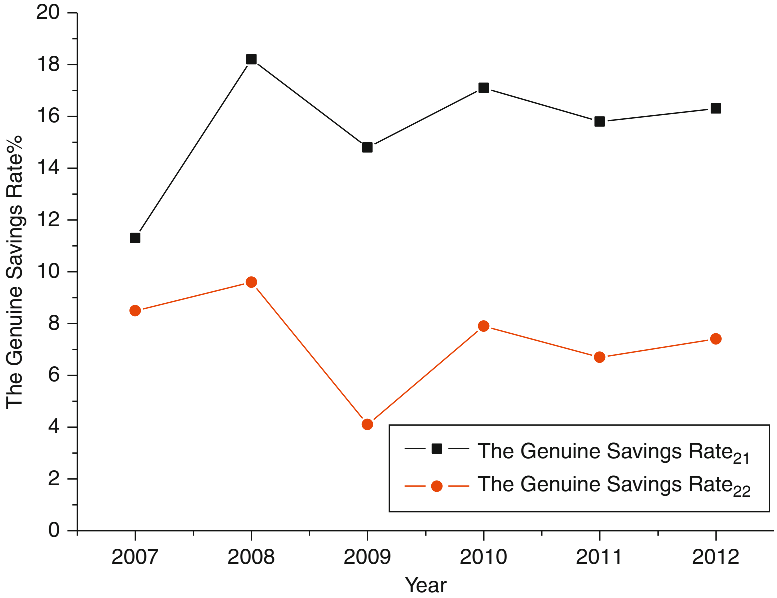

Fig. 1 The genuine savings rate of Mudanjiang from 2007 to 2012

the status of air pollutants TSP in this city is not optimistic. If this trend continues, the genuine savings ratio will go on decline and it may be close to zero or even negative.

5 The Sustainable Development Strategies and Recommendations of Mudanjiang City

1. Reduce the dependence on non-renewable resources and improve energy efficiency. The development of Mudanjiang city has no natural resource advantages. Improving energy utilization efficiency, developing low energy consumption and pollution industry, enhancing the use of renewable energy and vigorously developing new energy sources are effective ways of reducing the use of the renewable resources, increasing genuine savings so as to promote the city's sustainable developments (Feng-zhong Cao and Guomei Zhou 2001; Ru-song Wang 2001; Yong Chang et al. 2001).
2. Increase environment pollution management, particular in improving the worsening water pollution. Over the past few years the government of Mudanjiang city strengthened the administration of water environment and drinking water, surface water and related watershed quality have improved. However, due to the historic accumulation, water pollution loss showed in the people's health is still

increasing. It suggests that the government need to increase the sewage treatment investment, reduce environment pollution, which will gradually decrease the future water pollution loss of the city and enhance the city's sustainable development capacity.

3. Contain the decrease of farmland and wet area, strengthen the ecological planning of the city and reduce the erosion and destruction to ecological system due to the city expansion In order to further promote the sustainable development strategy of the city and make the city move toward eco-city, the urban environment capacity (land, water and environment) should be analyzed, the constraints of urban development should be made clear, and the size of the city should be reasonably, scientifically predicted. In particular, the development direction of urban land and spatial layout structure should be planned well. At the same time, urban transportation facilities should be examined and the infrastructure construction should be arranged and planed as a whole (Zhao-yi Huang and Dong-yuan Yang 2001).
4. Vigorously develop tourism and Strengthen the spiritual civilization construction. Tourism may gradually become the Mudanjiang City's economic growth point and pillar industry. Reasonable use of the ecological environment of the mountain area not only helps to accelerate the city's economic development, but also protects the source waters, such as lake and ecological sensitive area. In addition, disseminate the healthy culture, form good social climate, promote the harmonious development of mankind and nature, create a favorable urban cultural atmosphere, integrate the modern civilization and traditional culture, all of these actions are consistent with the principle of public participation of sustainable development (Lin Liu et al. 2000).

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General Aviation Flight Service Station Architecture Designing Based on Arena

Su-ling Jia and Fei Guo

Abstract Airlines spend enormous amount of effort and time developing flight schedules for each of their fleets. For General Aviation Flight, in China nowadays the low-altitude flight is not permitted and there is no service system to serve the general aviation flight. Due to the operations of airlines, the schedules always get cancelled or are caused delays because of some policy or environmental problems. In this paper firstly we create a 3-level General Aviation Flight Service System due to Chinese airline service condition, according to which we organize the process of flight schedule from applying for the flight plan to the end of the whole flight. Then we discuss the advantages of the new general aviation service system. Finally we simulate the whole service operation process. As a test case, we use ARENA simulation package to model the operations in the flight plan approval process. The service approach was found to be very effective in reducing the delay costs and maximize the profit.

Keywords Arena • Flight service • General aviation • Simulation optimize

1 Introduction

There are so many simulation papers about airline system, but most of them are simulating the flight plan in the hubs and paying more attention to the resource allocation like SIMMOD (Xia Qiangwei 2008). For the low altitude are not permitted in China, there is almost no article to discuss the flight plan about the general aviation flight plan approval process. Recent years the Aviation Administration continues carrying out new polices to imply the operational flight in low altitude,

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which means the existing general aviation service system is not enough to fulfill the requirement in the future. So designing a general aviation service system is an urgent requirement. After building a suitable general aviation service system, how to better operate the system and what is the responsibility of each department are the main problems to be discussed. The integration of management of aviation service will help to improve the efficiency of approval plan and the profit of the whole general aviation system. Using the simulation method will definitely help to optimize the model and give the required results, however, the OptQuest for Arena uses the variable and resource as the controlling parameters but cannot optimize multiple targets (Pan Yanchun et al. 2006). So we use the Visual Basic method to optimize and control the simulation model. In this paper, we focus the comparison between the different service mechanisms and the feasibility of the new general aviation service system.

2 Flight Service Station Description

2.1 The Service Station Architecture

Flight Service Station (FSS) (Federal Aviation Administration 2013) which stems from America is very important in the civil and general aviation. In America the FAA (Federal Aviation Administration) is responsible for the general aviation service including providing weather reports, flight plans, flight assistances and other services. This system not only helps the general aviation but also simplify the FAA's work. For China, because of the forbidden of the low altitude, we still don't have our own general aviation service system. With our country's rapid development we have more than hundreds of general airplanes, but we still use the old mechanism to apply the flight plan that the general aviation corporations need to send their flight documents to the civil aviation administration and army aviation administration firstly and wait for the results. For that the aviation administrations have too much work to do and need more time to deal with them, in the end the efficiency is very low. Besides general aviation firms have to communicate with the airports and book the environment and geology information from other administrations, so the existing approval system is not suitable. In this paper we first design a general aviation service station system in China and analyze each part of it.

In the beginning we will introduce our 3-level (Jin Shanzhou 2012) service system architecture as Fig. 1 shows. This picture shows the main parts of our service system including center station (CS), service station (SS), and the communication station (CMS). The center station is the head of all which is responsible for the integration of all activities, and through the center station all service station can operate smoothly. It coordinates all the activities and there is only one center station. The service station is the core of service system, because general aviation firms need to directly book the flight service such as flight plan approval, weather reports,

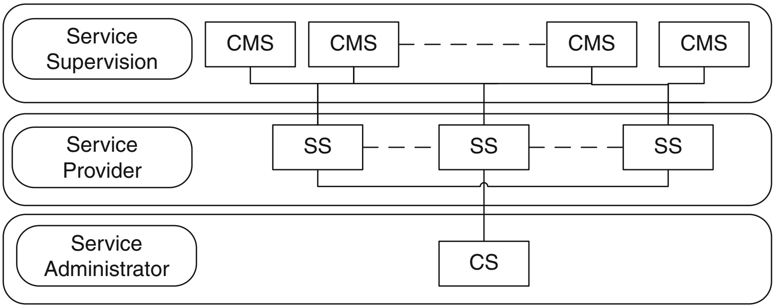

Fig. 1 3-level architecture

flight information and urgent assistance from it. The service station is the main part of the whole network. The lowest level is the communication station which is an auto station and its mission is to monitor the flight states and to communicate with both the aircraft commanders and the service stations. Communication stations are needed to do the 24-h work which requires powerful post and technology management systems.

As the interviews, General aviation firms have some problems. They said the approval cycle is their main problem and they have to apply for the airline to the army administration aviation for a long time such as the regular flight plan for 15 h. How to better schedule and get the effect weather and location information is still an unsolved problem. On one hand they don't have their own airport so sometimes they have to communicate with civil aviation airports. On the other hand, they have to give the priorities to civil planes. All these things make general aviation firms difficult to make plans. So the general aviation service system is warmly welcomed by all the general aviation firms. The Fig. 2 shows the relationship between different departments in the eco-system. In the general aviation service system architecture, every element has to build communication with the service station. The weather bureaus send weather reports to the center station and service station. In the new system only the service station and the center station need to order the weather report, and other firms only need to get information from them, at the same time kinds of service are booked together which will reduce the cost. For this system, general aviation firms first make their flight plan including the time, flight line, pilot etc. With the help from the service station, they don't have to go to the army and civil aviation administration departments and don't need to book weather reports, local information and flight information. All these service the can book from service stations. When the plans cross out the jurisdictional reach, the service stations should send them to the center station which will arrange all plans and together send to the right army and civil aviation firms. Though the integration, the service management efficiently reduces the cycle of approval process. When the plans are permitted, the general aviation firms have the communication service to from service station through all the flight process.

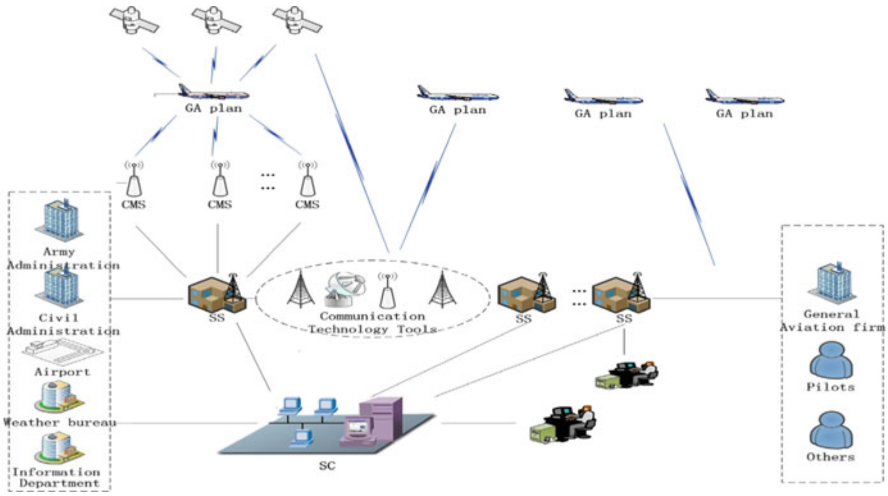

Fig. 2 Relationship between different departments in the eco-system

2.2 Advantages of FSS Architecture

The new FFS Architecture must help our national general Aviation field much better in many ways. For the administration, time consumption, cost, technology and process part not only the general aviation firms but also the civil aviation administration both get profit, which will also stimulate our country's general aviation industry. Table 1 will concisely show the advantages.

2.3 Service Process Description

Under the general aviation service system, the flight procedure meets a new process. The mission is to combine the business process, information process and the service process to improve the flight service efficiency. General aviation flight operation lifecycle from the plan approval to the flight landing is the main line. Figure 3 describes all the processes. This process includes four departments such as general aviation firm, service station, center station and communication station. For the flight lifecycle we divide it into two parts, which are flight plan approval as the first part and the flight procedure as the second part.

In the first part, the communication station is not considered. In the beginning, the general aviation firms accept the flight tasks and make their flight plans. Then they send the plan to the service station which the precondition is they have book the flight services. When the service station has received the plan they check the time, destinations, weather reports and other required information, then arrange

Table 1 Difference between architecture

Attribute	FSS	Non-FSS
Administration	One master. The center station is the head master and it just need to help the general aviation firms to communicate with army and civil aviation administration.	No master. General aviation firms have to communication with every department and get approval information. There is no core management center and if one of them doesn't permit the plans they cannot fly.
Time consumption	Save more time. General aviation firms don't need to send information to different places, and they just send them to service station and wait for the result. All the process they just have one service provider if they book the service.	Time waste more. General aviation firms have to firstly send plans to army and civil aviation administrator firstly. If they agree the planes they have to get the weather, geology and flight intelligence information from different places.
Cost	Less. FSS have to book all the information for all the general aviation firms, so the total cost is very low.	High. General aviation firms spend money for every part, so the cost is high.
Technology	High. FSS need a very high information system to help all the process. The communication station also need both communication and computer technology. Radar and satellite should be better.	Not high. All the processes are independent, so they not integrate all the material. Communication technology is worse than beidou satellite.
Process	Simplified. For the general aviation firms they just authorize the task to service station. And for other department they get the information once and batch deal with them effectively.	Complicated. For the general aviation firms they have many processes from different approval departments. And for other department they have to deal with all countries' plans several times.

the plans in the computer system. If the flight is out the jurisdictional reach they should send the flight information to the center station and wait for their reply. After receiving the information from the service stations the center commend its role to get the weather, geology, intelligence sky and airport information from weather report center, geology monitoring center, army aviation department and civil aviation administration. With the information they make sure whether the plan can be agreed and send the results back to the service stations. At the same time if

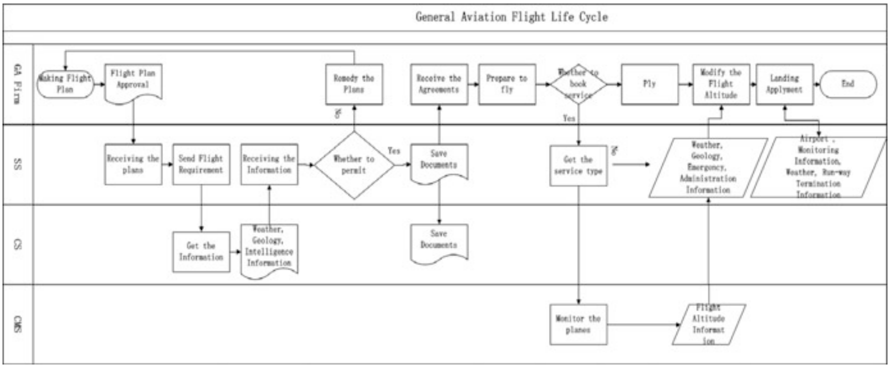

Fig. 3 General aviation flight life cycle

the plans are permitted, some airports will get the flight plan and start to arrange the flight schedules. Whether the plans are permitted the general aviation firms can get their service reports. If there is something wrong they will remedy their plans and send the updated plans to the service again. All the participants should save the documents. In this new service architecture, the application process definitely changed and simplified. Before the system one plan may be examined and approved 15 h at least except some urgent cases such as putting out a fire in the forest. And the previous preparations also cost some time, so the whole time and cost may be large. But the new system can deal with a plan at least 4 h. Therefore this service system constitutionally will help the whole general aviation chain.

In the second part, we focus on the flight services. Before the second part, all flight information such as flight line, task, destination and pilots are determined. What they need to do is to schedule the flight services from the service stations. When the plane flies, the communication stations will monitor the flight conditions and laugh sign to the service systems, then the information will be notified to the pilots, at the same time, the weather reports and the warning signal will be sent together. If there is some dangerous the center station will coordinate with the nearest service station to assist the general aviation plane. To land the airport the planes should get the agreement from the airport and the runway number. These are also for service station, they will help to arrange almost everything.

3 Simulation

3.1 Discrete Simulation System

The operation of the general aviation service process is a discrete simulation system, for which the changes only happened on the time spot and the time spots are not fixed. There are several researches about the aviation activities. Teodorvic and Guberinic (1984), Teodorovic (1988) firstly created the model to minimize the total delay for passengers, and optimized the flight tasks in the flight network with jam. Then he summarized the decide strategies in the disturbed stochastic problems including (1) canceling some of the flight plans to make the flight plans remain stable; (2) putting more flight plans; (3) importing some prepared flight plan tasks. Pushkar Kanitkar used the reinforcement leaning approach to reduce air carrier delay cost (Kanitkar 2008). Fang Shaoqiang et al. (2008) used the Arena to build the architecture of flight safeguard system in the airport. Yu Xiulan simulated the integrated scheduling policy for aircraft arrivals and optimized it (Yu Xiulan and Cheng Peng 2010). Pablo Cortes (2007) used Arena Simulate the freight traffic in the Seville inland port considering all types of cargo existing.

In this paper, we choose Arena (Rockwell Software 2006 Inc. Arena basic edition user's guide; Rockwell Software 2006 Inc. Arena Training Guide) as the simulation tool which is created by Ro Corporation. For Arena the optimization method is to use its OptQuest in the toolkit. However, the OptQuest uses the variable and resource as the controlling parameters and cannot optimize multiple targets. So we use the VBA with tabu search method to optimize and control the simulation model.

3.2 Simulation Optimization Principle

Simulation Optimization Problems (Pan Yanchun et al. 2006) are based on the target optimization problems and the principles showed as Fig. 4. It can be described that the output is decided by the input data and though optimizing we will get the best solution. It can be described as follows (April et al. 2003; Fu 2002):

$$\max p(\theta) = E[L(\theta, \zeta)] \tag{1}$$

$p(\theta)$ is the target property, in our paper we use as the average daily profit. $\theta \in \Theta$ is the decision variable. $\theta = \{\theta_A, \theta_B, \theta_C\}$ are presented for applications per day, the most applications station can deal with, the number that customer to wait. $L(\theta,\zeta)$ is the evaluation of total operational profit. ζ is the stochastic sound standing for the stochastic and undecided elements. Figure 4 shows the principle of simulation-based optimization.

The main features can be concluded as follows: (1) The solution of performance function can be got from simulation process. (2) There are undecided elements in the simulation process, in case of the errors, and we simulate more times to get the solutions. (3) The time of optimizing wastes more in the repeating simulation processes. (4) We use multiple targets.

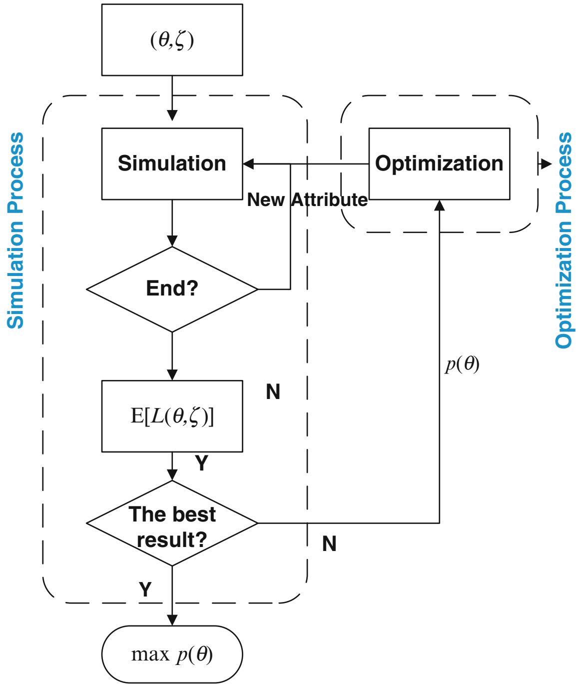

Fig. 4 The principle of simulation-based optimization

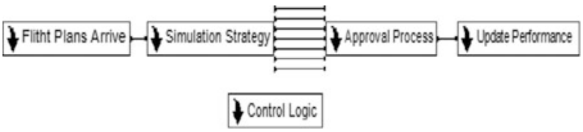

Fig. 5 Sub-modules of simulation-based optimization system

3.3 Simulation Architectures

The simulation architecture is composed of four submodules: Flight Plan Arrive, Simulation Strategy, Approval Process and Update Performance. Figure 5 shows the sub-module relations in the model.

1. Flight Plan Arrive submodule is used for creating and receiving the flight plans and in this process we need to make sure the Plan types and send them to the next module.
2. Simulation Strategy submodule is the choosing process, in which we can choose the best process to deal with the flight plan approval. Firstly it can judge the types of plans and know whether there are some finished processes and the unfinished processes. If the plan need to be scheduled, in this module it will comes to the next module approval process.

3. Approval Process submodule is accordance with the simulation strategy module to schedule the plan approval. When all the processes are finished it sends the plan to the simulation strategy module.
4. Update Performance submodule is the updating module, which rebuild the attributes when all the plans are finished.

When all these four processes are operating we use the control Logic sub-module to control the system.

3.4 Simulation Case

There is a general aviation flight service station system, and the GA firms can apply for the flight plan to the service station in their flight field. However each station has its own administration boundary. There are about 10–50 flight service requirements every day, obeying the Poisson distribution, which are divided for three types. The first one is unscheduled flight within the boundary which should be applied to the service station beyond TRIA (39, 41, 43) hours. The second one is unscheduled flight without the boundary which should be applied to the service station beyond TRIA (72, 74, 76) hours. The third one is scheduled flight which should just be approved once and then they just need to apply to the service station beyond TRIA (4, 5, 6) hours. The proportion is 2:2:1. We assume the Book time is the operation time which obeys DISC (0.4, 4, 0.8, 8, 1, 12). However the actual time obeys GAMM (Book time/1.05, 1.05) distribution. The Service Station works 12 h a day and 7 days per week, and we assume three departments to do the job together. In the case when the service can't finish on time, 70 % general firms will wait for the service, and the first type of application will not wait extent for 2 days and the third type must be finished in 1 day. The daily cost is 60 yuan/h, overtime cost is 150 yuan/h, and the income per hour is 90 yuan/h. Our target is to maximize the daily profit. In order to let less wait time, we make the constrains as Daily Late Wait Jobs <=0.5 and Daily Overtime <=3.

The equation as follows:

$$\begin{aligned}&Max\ p\,(\theta)\\ s.t.&\begin{cases}10 <= Calls\ per\ day <= 50\\ 20 <= Max\ Load <= 36\\ 1 <= Max\ Wait <= 3(Discrete)\end{cases}\end{aligned} \tag{2}$$

The result shows as Fig. 6: Every service station can receive about 29 flight applications, 25.56 h book time and three customers to wait. The highest profit is about 1,614 yuan per day. Table 2 shows the optimization results.

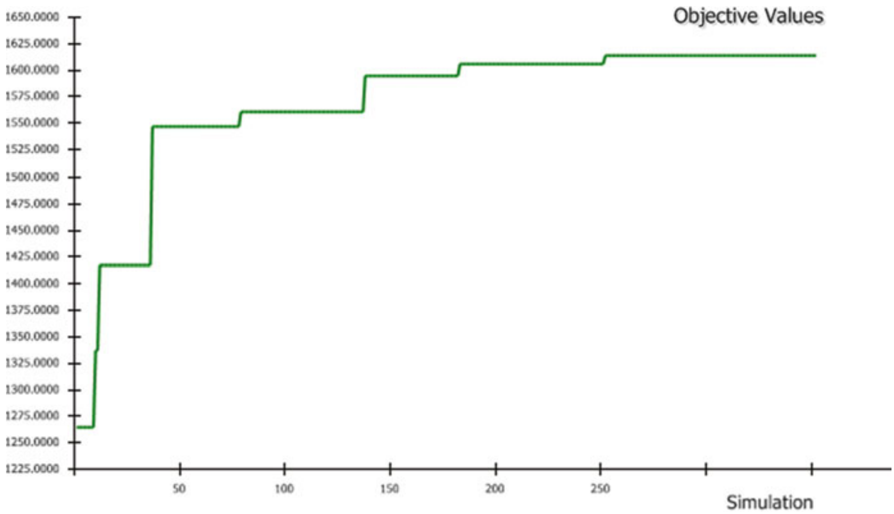

Fig. 6 Objective values and best values list

Table 2 Optimization results

No.	Daily profit	Calls per day	Max load	Max wait
252	1,613.8971	29.0823	25.555	3
200	1,606.6228	29.0823	25.5497	2
213	1,560.8448	17.1758	27.3189	3
247	1,560.8447	17.1712	25.5965	2
119	1,546.8862	17.1983	27.8186	3
223	1,481.4488	17.1820	26.716342	3
...	...	...	...	...

4 Conclusion

In this paper we have created a general aviation flight service system, at the same time, and we have list the whole process. Besides we analysis the advantages of the new system and with Arena simulation tool we simulate the process of flight approval process. At list we give an example to show how we do this. The system has highly intelligent and effective abilities than the existing system. The next step we will focus on the flight process on different conditions. However, there are more to improve such as the cost and the price is not determined but we can change the characters to get the result. Therefore we need more data to support the simulation model. At the same time, we need more professional suggestions about how to optimize the models.

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Application of 3D Scene Building Technology in Crane Simulation Platform Based on OSG

Qian-wang Deng and Xiao-lai Liu

Abstract For more predictable and secure crane in operation process, with senior rendering engine OSG and visual development tool Visual C++ as development infrastructure, database principle and the ADO technology have been applied to establish real-time parametric model library, meanwhile, the all-terrain crane hoisting 3D simulation platform is developed. Therefore, user could observe crane operation of the whole simulation process in 3D virtual scene from a different perspective, and the lifting program generated by collision-free path planning can guide the user's actual operation. This paper introduces the real-time parametric model library, virtual 3D scene building processes and specific methods. The example of all-terrain crane hoisting 3D simulation platform application indicates that the 3D virtual scene building technology based on OSG can be widely used in engineering simulation to solve existing problems.

Keywords All-terrain crane • OSG • Parameterized model library • Scene building • Simulation platform

1 Introduction

Crane plays an important role in the construction and the security in the operation of crane has been a concern due to its nature with a special operating environment and process (Wang et al. 2010). In fact, in addition to the high reliability of parts, the operator proficiency and technical level are also important to ensure safety in the

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operating process (Dong et al. 2009). Since the dangerous and destructive process of crane operation is irreversible, large hoisting operations should be conducted through a crane 3D simulation platform. Currently, most crane 3D simulation platforms are carried out by means of 2D graphical visualization of simulation data, which cannot show real operation scene vividly. Considering that, a few crane manufacturers have developed 3D simulation platform, where only a simple demonstration of crane operating procedure and scene roaming is achieved (Gao et al. 2010; Guo and Zhou 2009).

With senior rendering engine OSG and visualization tool Visual C++ as its development basis, the paper developed the all-terrain crane hoisting 3D simulation platform by using 3D scene building technology based on OSG. This simulation platform has been realized with engineering management, virtual 3D scene building, crane operating mode selection, motion simulation, program outputting and real-time scene roaming.

2 The Overall Structure of the 3D Simulation Platform

The all-terrain crane hoisting 3D simulation platform consists of five modules: engineering management module, crane operating mode selection module, lifting scene to build module, the crane motion simulation module as well as lifting program output module, as shown in Fig. 1.

Among the modules, lifting scene to build module is the core and basic module of the platform. It includes human-computer interaction, view switching, scene building, internal model library management and external models import, as shown in Fig. 2.

3 Virtual Scene Building Technology

Without actual physical product or support process, virtual scene building technology is based on digital design and physical implementation. It adopts the digital virtual model, visualization and data expression means to provide a virtual environment with immersion, interactivity and imagination (Wang and Zhao 2010; Hubbard 1995).

3.1 *Scene Building Technology Based on OSG*

OSG is a high-performance 3D graphics engine, based on the modified LGPL agreement (OSGPL), which is published free of charge (Wang and Qian 2009). It is widely used in digital simulation, scientific visualization and engineering field

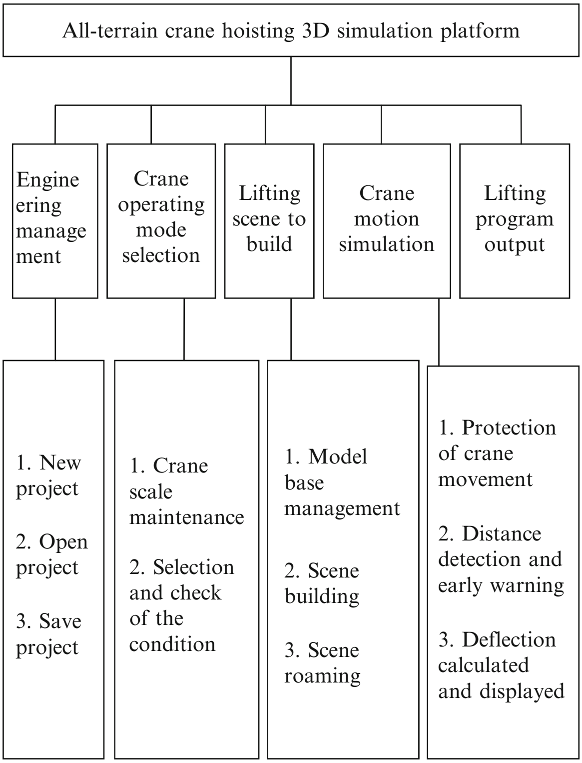


Fig. 1 System structure

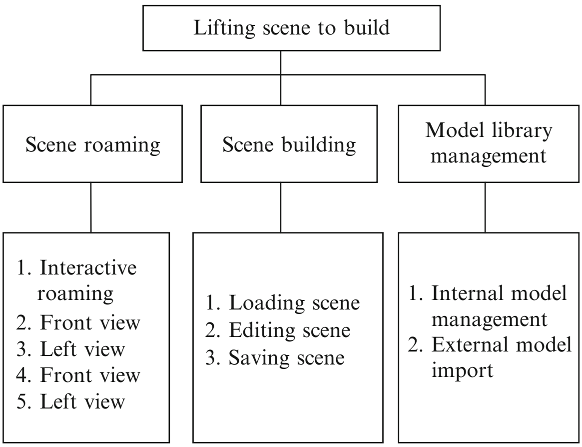
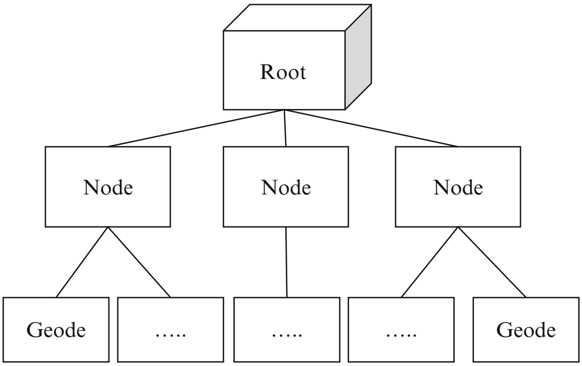


Fig. 2 Scene building module structure

including computer-aided design CAD, digital content creation DCC and virtual reality (Cao and Zhu 2007).

To build a lifelike virtual scene, a large number of model objects needs to be created and maintained. It will be an extremely complex and difficult task to manage

Fig. 3 Node tree structure



the scene model better (Xiang and Li 2012). This platform uses a surrounded hierarchy (Bounding Volume Hierarchy, BVH) to achieve the management of the three-dimensional scene model, using the scene tree to save the information. A scene tree includes a root node and multi-level internal minor node as well as the end of the leaf nodes, as shown in Fig. 3.

The method of transformation nodes in OSG is divided into two kinds. The first is to set the value of the transformation matrix directly. The second is to set the value of the location pointer directly to control node translation, rotation and scaling. The latter has been used in the actual process, proves more convenient in usage and easier to comprehend (Yan 2008; Guo et al. 2010). It's necessary to modify the model in 3D virtual scene because different order of operations will directly lead to a completely different result during the implementation of object translation, rotation and scaling operation.

Space transform node will usually be in accordance with the sequence of operation of the SRT (Scale/Rotate/Translate) to complete the transformation of the composite matrix. Its formula, as in (1):

$$M = Ms^{*}Mr^{*}Mt. \tag{1}$$

Where, Ms, *Mr*, *Mt* respectively represent scaling matrix, rotation matrix and translation matrix respectively, according to mathematical knowledge, the following matrix expression is available:

(a) Scaling matrix

$$Ms = \begin{bmatrix} sx & 0 & 0 & 0 \\ 0 & sy & 0 & 0 \\ 0 & 0 & sz & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

(b) Translation matrix

$$Mt = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ tx & ty & tz & 1 \end{bmatrix}$$

(c) About the X-axis rotation matrix

$$Mrx = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & \cos\theta & -\sin\theta & 0 \\ 0 & \sin\theta & \cos\theta & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

(d) About the Y-axis rotation matrix

$$Mry = \begin{bmatrix} \cos\theta & 0 & \sin\theta & 0 \\ 0 & 1 & 0 & 0 \\ -\sin\theta & 0 & \cos\theta & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

(e) About the Z-axis rotation matrix

$$Mrz = \begin{bmatrix} \cos\theta & -\sin\theta & 0 & 0 \\ \sin\theta & \cos\theta & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{bmatrix}$$

They often take scale(), rotate() and translate() function to express, namely: osg:Matrix $srt =$

osg::Matrixd::scale(osg::Vec3d(*sx*,*sy*,*sz*))
*osg::Matrixd::rotate(osg::Quat(*angle*,*axis*))
*osg::Matrixd::translate(osg::Vec3d(*tx*,*ty*,*tz*))

The physical meaning of the various parameters is shown in Fig. 4.

3.2 Real-Time Parametric Model Library

As realistic environment is very complex and ever-changing, the real-time parametric model library needs to be built in order to build the virtual scene quickly and conveniently, which is consistent with the lifting scene (Shi et al. 2009).

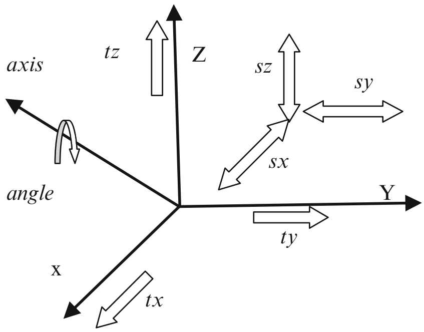


Fig. 4 Physical meaning of the transform values

Real-time parametric model library building design is different from the traditional design for it stores the mode which is required in scene building process, and is able to design similar models in shape and function (Wang et al. 2008; Carson 2005). Based on the characteristics mentioned above, this system applied the principles of relational database Access and ADO connection technology to build the real-time parametric model library.

Crane lifting scene model library mainly includes crane model library, lifting object model library, obstacle model library, sling model library as well as background model library. All 3D information models are stored in a relational database management system Access table.

First of all, use the external modeling software to create 3D digital model and apply the relational database management system Access to build 3D model of attribute information and information table structure.

Secondly, apply the principles of database and ADO technology, in order to read the model size table in the database model information.

Finally, the application of high-performance 3D graphics engine based on OSG and MFC framework calls for the corresponding function of OSG to create and modify 3D model in real time. Its specific build process is shown in Fig. 5.

4 All-Terrain Crane Hoisting 3D Simulation Platform Application Example

All-terrain crane hoisting 3D simulation platform is geared to the needs of crane industry, applying to hoist designers to develop the lifting scheme and the lifting process visual simulation. Crane operation of the entire simulation process is observed in the 3D virtual scene based on the collision-free path planning and lifting program to obtain the simulation report for lifting scheme and to guide the user's actual operation.

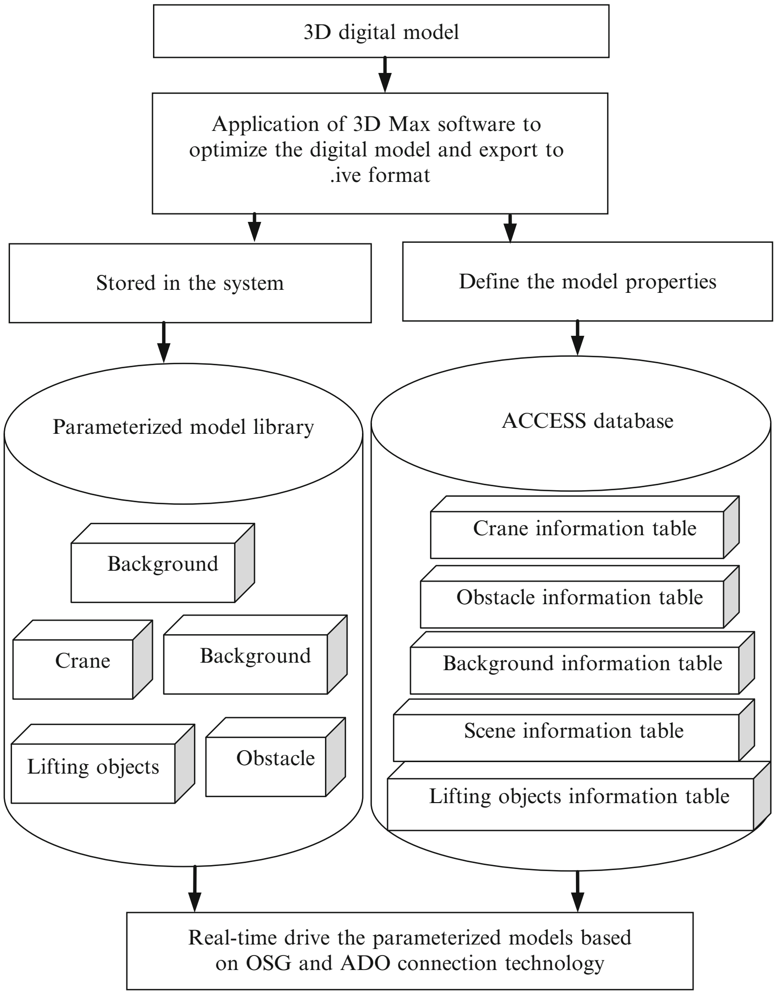
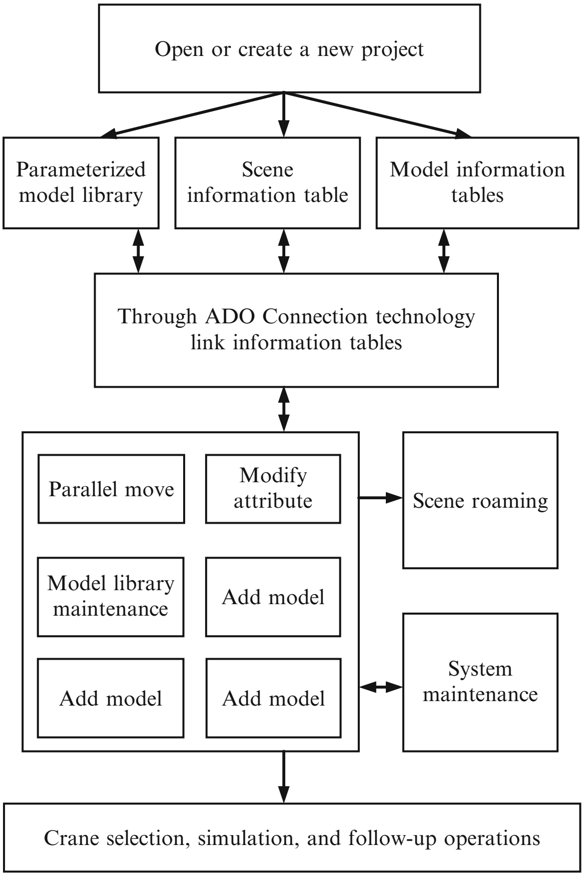


Fig. 5 Model library build process

4.1 Build a Virtual Lifting Scene

The simulation platform provides eight initial scenes according to the actual working conditions (wind power scene, thermal power scene, nuclear power scene, building scene). The complexity of the actual working conditions is beyond the situation of system development, which requires users to add the 3D model of each scene category to the scene, detailed 3D virtual scene building process is shown in Fig. 6.

Fig. 6 Scene building process



The process of building a crane operation scene will involve a series of human-computer interactions (such as add model, modify attributes, delete model, add sling, parallel move and so on), one of the most critical interaction is the model of the picking up and real-time updating of data in the information table (Wu et al. 2008). Now take the all-terrain crane hoisting 3D simulation platform for example, the specific implementation steps are given.

Step 1: Create the intersection sets pointer intersections by OSG class.
Step 2: Issue a ray from the point of the screen position, when the mouse is released.
Step 3: Judge whether the ray intersects with the objects, if so, the coordinate information of intersection points will be stored in the intersection pointer.
Step 4: Observe the intersection of the sets pointer value to determine whether the model has been picked up, if not empty, the model picked up will become highlighted, and the name of the model identification will be obtained. Utilizing the node-visitor to identify the name of the corresponding node in the node tree.
Step 5: Control node, the interaction scenario is shown in Fig. 7.

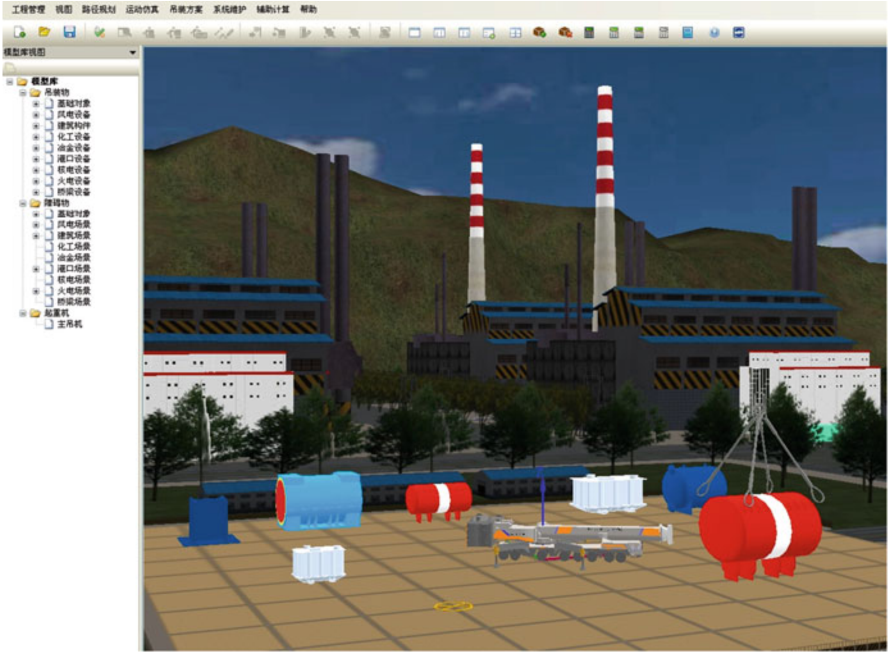


Fig. 7 Interaction scenario

4.2 Scene Roaming

Scene roaming can be roughly divided into stationary scene roaming and interactive scene roaming (Lu 2010). The all-terrain crane hoisting 3D simulation platform is interactive scene roaming, whose viewpoint is self-defined by the user. There is a lot of flexibility with the mouse and keyboard to control its forward, backward and steering process.

This simulation platform provides users with the eight kinds of roaming operations (including the back, the left, the right, left rotation, right rotation, move up, move down) and five view modes (including the main view, left view, right view, top view, split view). The split view is shown in Fig. 8.

5 Conclusion

It is successful to apply the scene building technology based on OSG and develop the all-terrain crane hoisting 3D simulation platform. This simulation platform has realized virtual scene construction, crane motion simulation, human-computer interaction and scene roaming, which fully shows the 3D virtual scene building

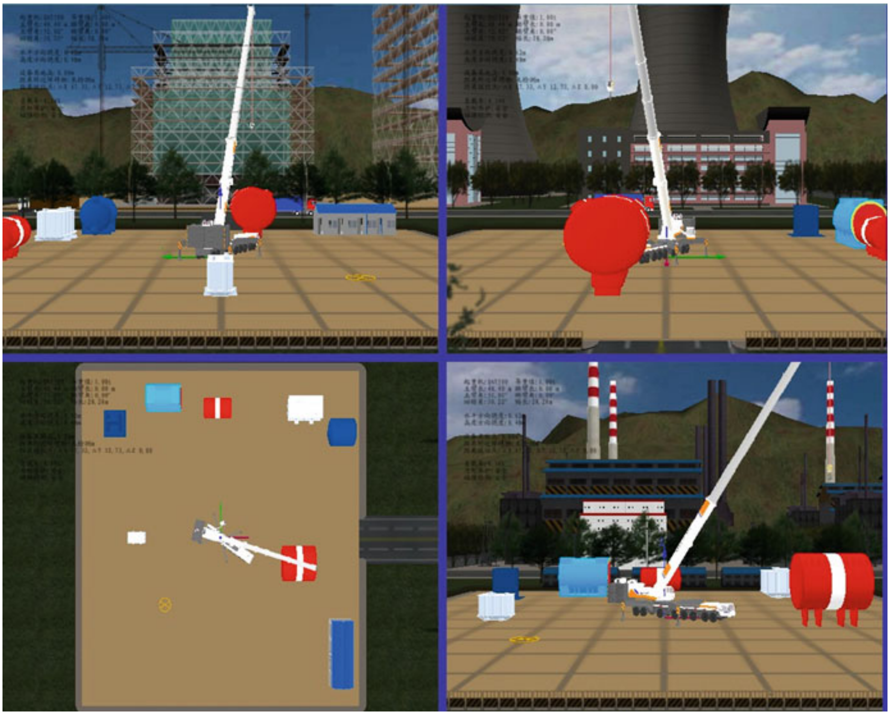


Fig. 8 Split view

technology based on OSG can be used in the field of engineering simulation and is able to solve practical problems in engineering, making the project more predictable and secure and provide a feasible basis for large-scale projects.

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Multivariate Statistical Process Monitoring Scheme with PLS and SVDD

Jia Liu and Yan-guang Sun

Abstract In order to adaptably monitor product qualities during real industrial process, a new multivariate statistical process monitoring scheme combining projection to latent spaces (PLS) and Support Vector Domain Description (SVDD) is proposed. PLS can establish the monitoring space, which maximizes the correlation between process variables and quality variables and enable product qualities monitoring through process variables. SVDD can define the admissible domain by normal operation data without constraints about data distribution. Moreover, with kernel functions it can even provide a tight admissible domain for the operation data. Such characteristics make it suitable for practical production processes. This scheme is then applied to Tennessee Eastman process, and its efficiency for fault detection is proved by introducing simulated process faults. Analysis about its limits in fault detection is also presented.

Keywords Kernel functions • Multivariate statistical process monitoring • Projection to latent spaces (PLS) • Support vector domain description (SVDD) • Tennessee Eastman process

1 Introduction

Multivariate statistical process monitoring (MSPM), which normally combines multivariate statistical tools and control charts to detect process faults or abnormal operating situations, is successfully applied in many industrial processes (Chiang et al. 2001; Yin et al. 2012; Kourti and MacGregor 1995).

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The multivariate statistical tools, including principal component analysis (PCA), independent component analysis (ICA), and projection to latent spaces (PLS), are used to handle the large number of highly correlated variables and to reduce the dimension of the monitoring spaces. Control charts are then used for process monitoring by constructing statistical index for operation data and comparing with the threshold calculated with normal operation data.

Such monitoring methods have limitation. Assumption about process data distribution is needed, e.g. Gaussian distribution for PCA and PLS, which is not necessarily satisfied in practical industrial environment. Thus process monitoring based on statistical index may lead to misdetection.

After Support Vector Domain Description (SVDD) has been brought up by Tax and Duin (1999, 2004), monitoring schemes by combining multivariate statistical tools with SVDD successfully bypass this limitation and are used in several practical industrial applications, such as machine fault detection (Tax et al. 1999; Ypma et al. 1999; Liu et al. 2012; Widodo et al. 2007). As a method for data domain description, SVDD calculates a sphere shaped decision boundary with minimal volume around a set of objects. If new measured samples locate outside the boundary during process monitoring, these samples are categorized as abnormal.

PLS can monitor and predict final product quality (**Y**) by decomposing process variables (**X**) according to their influence on quality variables and by monitoring the variations in **X**. Since quality data **Y** are difficult to measure, and often come very infrequently with significant delays, monitoring method by PLS could be a useful and direct indication to monitor and predict products quality in real production scenario (Chiang et al. 2001).

In the article, we propose a useful and practical process monitoring methods combining PLS and SVDD, not only avoiding assumption about process data distribution, but predicting the final product qualities which cannot be acquired by other statistical monitoring scheme.

The rest of the paper is organized as following. Section 2 introduces the methodologies used in this multivariate process monitoring scheme, including PLS, SVDD, and the procedures of the monitoring scheme. The method is applied in Tennessee Eastman process, and both its effects and limitations in process monitoring are analyzed in Sect. 3. Finally the conclusions are presented in the last section.

2 Methodology

2.1 Projection to Latent Spaces (PLS)

PLS is a multivariate statistical tool which emphasizes the correlation between process variables (**X**) and quality variables (**Y**). After decomposition on **X**, it can form a low-dimensional latent space and residual space. By monitoring variations in the process variables that are most relevant to **Y**, PLS can be used to monitor and to predict quality variables **Y** (Chiang et al. 2001; Li et al. 2010).

Given an input matrix $\mathbf{X} \in R^{n \times m}$ including n samples with m process variables, and an output matrix $\mathbf{Y} \in R^{n \times p}$ with p quality variables, scale them to unit variance and zero mean. PLS projects (**X, Y**) to a low dimensional space defined by a small number of latent variables $(\mathbf{t}_1, \ldots, \mathbf{t}_A)$:

$$\begin{aligned} \mathbf{X} &= \mathbf{T}\mathbf{P}^{\mathrm{T}} + \mathbf{E} \\ \mathbf{Y} &= \mathbf{T}\mathbf{Q}^{\mathrm{T}} + \mathbf{F} \end{aligned} \tag{1}$$

In (1), $\mathbf{T} = [\mathbf{t}_1, \ldots, \mathbf{t}_A]$ is called score matrix, $\mathbf{P} = [\mathbf{p}_1, \ldots, \mathbf{p}_A]$ and $\mathbf{Q} = [\mathbf{q}_1, \ldots, \mathbf{q}_A]$ are loading matrices of **X** and **Y**. **E** and **F** are the residual of **X** and **Y**.

In PLS, the score matrix maximizes the variance of the quality variables explained by the process variables. For new sample sets, PLS uses their calculated scores to represent the data and estimate the final quality.

Nonlinear iterative partial least-squares algorithm (NIPALS) introduced by H. Wold (1975) is commonly used to perform PLS by finding the solution of (2):

$$\begin{aligned} &\max \mathbf{w}_i^{\mathrm{T}} \mathbf{X}_i^{\mathrm{T}} \mathbf{Y}_i \mathbf{q}_i \\ &s.t. \|\mathbf{w}_i\| = 1, \|\mathbf{q}_i\| = 1 \end{aligned} \tag{2}$$

where $\mathbf{w}_i$ belonging to $\mathbf{W} = [\mathbf{w}_1 \ldots \mathbf{w}_A]$ is weight vector that calculates $\mathbf{t}_i = \mathbf{X}_i \mathbf{w}_i$, but **T** cannot be calculated from **X** directly using **W**. So arrange

$$\begin{aligned} \mathbf{r}_1 &= \mathbf{w}_1; \\ \mathbf{r}_i &= \prod_{j=1}^{i-1} \left(\mathbf{I}_m - \mathbf{w}_j \mathbf{p}_j^{\mathrm{T}}\right) \mathbf{w}_i, \quad i > 0 \end{aligned} \tag{3}$$

and $\mathbf{R} = [\mathbf{r}_1, \ldots, \mathbf{r}_A]$. Then, the score matrix **T** can be computed from the process variables **X** as in (4):

$$\mathbf{T} = \mathbf{X}\mathbf{R} \tag{4}$$

Moreover, **P**, **R** and **W** have the following relation (De Jong 1993):

$$\mathbf{R} = \mathbf{W}\left(\mathbf{P}^{\mathrm{T}}\mathbf{W}\right)^{-1} \tag{5}$$

$$\mathbf{P}^{\mathrm{T}}\mathbf{R} = \mathbf{R}^{\mathrm{T}}\mathbf{P} = \mathbf{W}^{\mathrm{T}}\mathbf{W} = \mathbf{I}_{\mathrm{A}} \tag{6}$$

2.2 Support Vector Data Description (SVDD)

SVDD inspired by the Support Vector Machine is to describe an admissible domain with a class of a dataset (Tax and Duin 1999, 2004). It contains support vectors describing the sphere boundary. By using the different kernel functions in SVDD, it could get higher order boundary descriptions without much extra computational cost.

To start with the normal data description, a sphere to encircle the data with a closed boundary is defined with center **a** and radius R. We minimize the volume of the sphere by minimizing R^2, and the sphere must include all training objects $\mathbf{x}_i$.

To consider the possibility of outliers in the training set, the distance from $\mathbf{x}_i$ to the center **a** need not be strictly less than R^2, but bigger distances should be penalized. So slack variables $\xi_i \geq 0$ are introduced and minimizing R^2 changes to:

$$\begin{aligned} &\text{Min } F(R, \mathbf{a}) = R^2 + C \sum_i \xi_i \\ &s.t. \|\mathbf{x}_i - \mathbf{a}\|_2 \leq R^2 + \xi_i, \quad \xi_i \geq 0 \end{aligned} \tag{7}$$

The parameter C in (7) controls the compromise between the volume and the errors. Constraint can be added to (7) by using Lagrange multipliers:

$$\begin{aligned} L(R, \mathbf{a}, \alpha_i, \gamma_i, \xi_i) &= R^2 + C \sum_i \xi_i - \textstyle\sum_i \gamma_i \xi_i \\ &- \textstyle\sum_i \alpha_i \left\{ R^2 + \xi_i - \left(\|\mathbf{x}_i\|^2 - 2\mathbf{a} \cdot \mathbf{x}_i + \|\mathbf{a}\|^2 \right) \right\} \end{aligned} \tag{8}$$

with the Lagrange multipliers $\alpha_i \geq 0$ and $\gamma_i \geq 0$.

Only object $\mathbf{x}_i$ with $\alpha_i > 0$ is used in the data description and they are called the support vectors (SVs) of the description. Support vectors with $\alpha_i = C$ fall outside the boundary and are excluded from the description.

So in the sphere, the center **a** is a linear combination of all the objects. R^2 is the distance from center **a** to any of the support vectors on the boundary. So:

$$\mathbf{a} = \frac{\sum_i \alpha_i \mathbf{x}_i}{\sum_i \alpha_i} = \sum_i \alpha_i \mathbf{x}_i \tag{9}$$

$$R^2 = (\mathbf{x}_k \cdot \mathbf{x}_k) - 2 \sum_i \alpha_i (\mathbf{x}_i \cdot \mathbf{x}_k) + \sum_{i,j} \alpha_i \alpha_j \left(\mathbf{x}_i \cdot \mathbf{x}_j \right) \tag{10}$$

for any $\mathbf{x}_k \in$ SVs, where $0 < \alpha_k < C$.

To test a new sample **z**, the distance to the center **a** need to be calculated. **z** is considered normal if the distance is no larger than the radius:

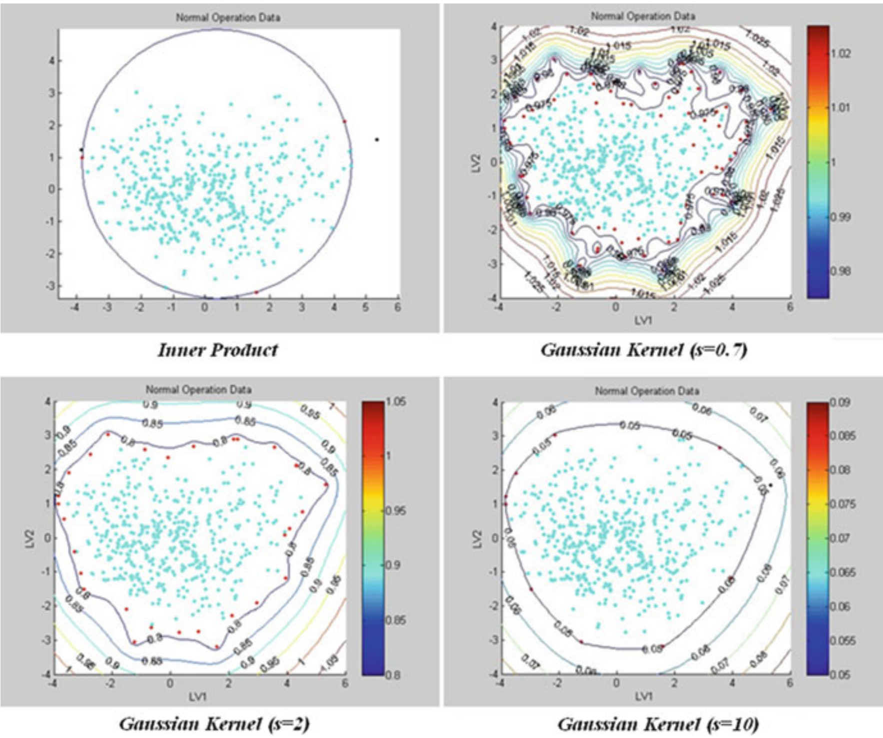

Fig. 1 Data boundaries with different SVDD

$$\|\mathbf{z}-\mathbf{a}\|_2 = (\mathbf{z}\cdot\mathbf{z}) - 2\sum_i \alpha_i \left(\mathbf{x}_i\cdot\mathbf{x}_j\right) + \sum_{i,j}\alpha_i\alpha_j\left(\mathbf{x}_i\cdot\mathbf{x}_j\right) < R^2 \tag{11}$$

Process monitoring scheme is established based on (11). If the test samples locate out of the sphere, the operation deviate its normal condition.

In order to get a more flexible data description, substitute the inner product $(\mathbf{x}_i \cdot \mathbf{x}_j)$ with a kernel function $\boldsymbol{K}(\mathbf{x}_i,\ \mathbf{x}_j) = (\Phi(\mathbf{x}_i)\cdot\Phi(\mathbf{x}_j))$, where Φ is an implicit nonlinear mapping of the data into another feature space, possibly high dimensional hypersphere. An ideal kernel function would project the target data onto a bounded, spherically shaped area in the feature space and outliers outside this area. Then the hypersphere model would fit the data. One of the common kernel functions is Gaussian kernel:

$$\boldsymbol{K}\left(\mathbf{x}_i,\mathbf{x}_j\right) = \exp\left(-\|\mathbf{x}_i-\mathbf{x}_j\|^2/s^2\right) \tag{12}$$

Figure 1 shows different data boundaries drawn by SVDD with inner product and with Gaussian kernel using different parameter s.

Two phenomena are observed from Fig. 1: Firstly, the descriptions with Gaussian kernel are much tighter than the one with inner product; secondly, with the increasing of parameter *s* in Gaussian kernel, the number of support vectors decreases, and the boundary become loser. However, the generalization ability of the description is enhanced. Therefore, when kernel function is applied in SVDD, it is advised to choose suitable parameters to get the balance between generalization and tightness.

2.3 Process Monitoring With PLS-SVDD

If PLS and SVDD are combined for process monitoring, then the scheme will possess the advantages of both techniques, i.e. monitoring the quality variables and circumventing the presupposition about data distribution. Therefore, such process monitoring scheme would be very suitable for real industrial environment, where the distribution of process data is unknown and prediction for quality is difficult.

There are three major steps for establishing process monitoring scheme with PLS-SVDD.

First, use PLS to extract latent variables and construct the monitoring space from selected normal operation data.
Second, use SVDD to define the admissible domain for the normal process data in the monitoring space.
Third, project the test data into the monitoring space.

In the monitoring space, normal operation data are always clustered together, which could be circumscribed by a tight boundary defined by SVDD as shown in Fig. 2.

The test data are mapped into the monitoring space by PLS and represented by latent variables. If the data are observed out of the admissible domain as in Fig. 3, it means faults affecting product qualities happen in process.

From the above theoretic analysis about the process monitoring scheme with PLS and SVDD, if such process monitoring scheme is applied to practical industrial process, the process faults which influence product qualities could be detected in a demonstrative way.

3 Application and Results

The process monitoring scheme with PLS and SVDD is applied in Tennessee Eastman process for analysis.

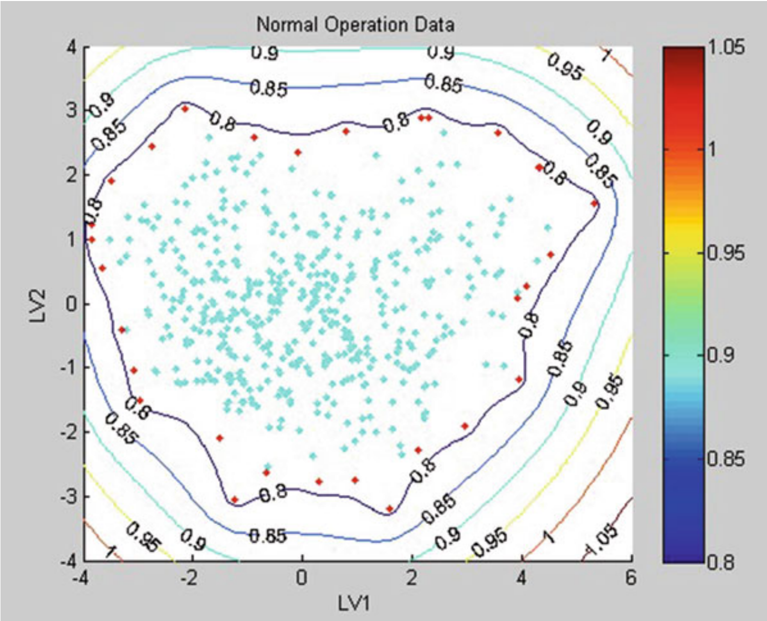

Fig. 2 Normal data boundary in monitoring space

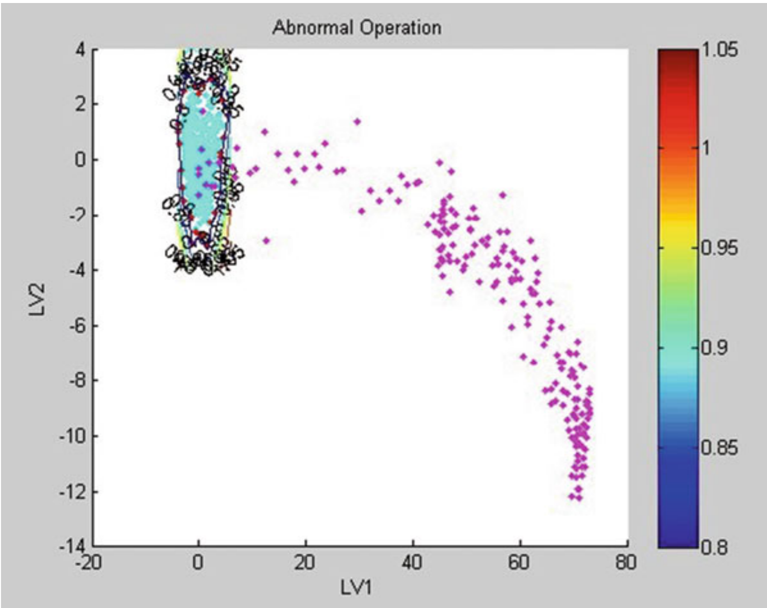

Fig. 3 Abnormal data applied to monitoring space

3.1 Tennessee Eastman Process

The Tennessee Eastman (TE) process is a hypothetical chemical plant described by Downs and Vogel (1993), which has been used as an industrial benchmark to illustrate the efficiency of different algorithms.

The process produces two products, G and H, from four reactants A, C, D and E. F is byproduct.

$$
\begin{array}{ll}
\mathrm{A\,(g) + C\,(g) + D\,(g) \rightarrow G\,(liq)}, & \text{product 1,} \\
\mathrm{A\,(g) + C\,(g) + E\,(g) \rightarrow H\,(liq)}, & \text{product 2,} \\
\mathrm{A\,(g) + E\,(g) \rightarrow F\,(liq)}, & \text{byproduct,} \\
\mathrm{3D\,(g) \rightarrow 2\,F\,(liq)}, & \text{byproduct.}
\end{array}
$$

The process allows total 52 measurements out of which 41 are of process variables and 11 are manipulated variables. Twenty process faults are defined as in Table 1. According to the original TE code, a Simulink code provided by the Lawrence Ricker (1996) is available to simulate the plant's closed-loop behavior. It can be downloaded from http://depts.washington.edu/control/LARRY/TE/download.html.

3.2 Monitoring Scheme Application in TE

TE process is employed to illustrate the effects of process monitoring scheme with PLS and SVDD. As mentioned in Sect. 2, monitoring space is established by PLS using normal operation data and boundary is defined by SVDD with Gaussian kernel. Test data with process faults are then projected into the monitoring space to illustrate the effects of the scheme.

In the simulation, 22 process variables (XMEAS(1–22)) and 11 manipulated variables (XMV(1–11)) are included in PLS as input variables, the indicator for component G (XMEAS(35)) is treated as product quality variable.

Collect 24 operation hours' normal operation data with sampling time of 3 min. So there are total 480 training sets recorded. PLS algorithm is applied to the training data to reduce data dimension and establish monitoring space. The number of LVs is selected as 2 according to cross validation based on PRESS statistics (Wold 1975; De Jong 1993). Then SVDD with Gaussian kernel is used to define a boundary for the normal data as shown in Fig. 4.

Among the thirteen independent faults in Table 1, the fault IDV (1), a step disturbance to A/C feed ratio, is first introduced to the process for 10 h and 200 test sets with the same sampling frequency are recorded. These abnormal data are then projected into the monitoring space and displayed in Fig. 5 as blue spots. We notice that except a few spots in the boundary, most of the abnormal data locate far

Table 1 The process faults in TE process

Variable No.	Process variable	Type
IDV (1)	A/C feed ratio, B composition constant	Step
IDV (2)	B composition, A/C feed ratio constant	Step
IDV (3)	D feed temperature	Step
IDV (4)	Reactor cooling water inlet temperature	Step
IDV (5)	Condenser cooling water inlet temperature	Step
IDV (6)	A feed loss	Step
IDV (7)	C header pressure loss-reduced availability	Step
IDV (8)	A, B, C feed composition	Random
IDV (9)	D feed temperature	Random
IDV (10)	C feed temperature	Random
IDV (11)	Reactor cooling water inlet temperature	Random
IDV (12)	Condenser cooling water inlet temperature	Slow drift
IDV (13)	Reaction kinetics	Sticking
IDV (14)	Reactor cooling water valve	Sticking
IDV (15)	Condenser cooling water valve	Unknown
IDV (16)	Unknown	Unknown
IDV (17)	Unknown	Unknown
IDV (18)	Unknown	Unknown
IDV (19)	Unknown	Unknown
IDV (20)	Unknown	Unknown

Disturbance 14–20 should be used in conjunction with another disturbance from the table or a setpoint change

away from the admissible domain and can be easily distinguished from the normal data.

If we zoom in the admissible domain in Fig. 6, it shows that only the first 10 spots are in the domain with the trend of gradually moving near to the boundary; from the 11th spot, the test data are all out of the boundary.

The delayed fault detection can be explained by the fact that the effect caused by fault IDV (1) on product quality is not immediately shown. Still, the data displayed the trend of diverging from normal operation until the deviation is big enough to transgress the boundary.

When fault IDV (5), disturbance of condenser cooling water inlet temperature, is introduced to the process, the abnormal data, shown in Fig. 7 as blue spots, mix with normal data in the admissible domain and cannot be distinguished from one another. It seems that unfortunately not all the faults can be detected by monitoring scheme with PLS-SVDD.

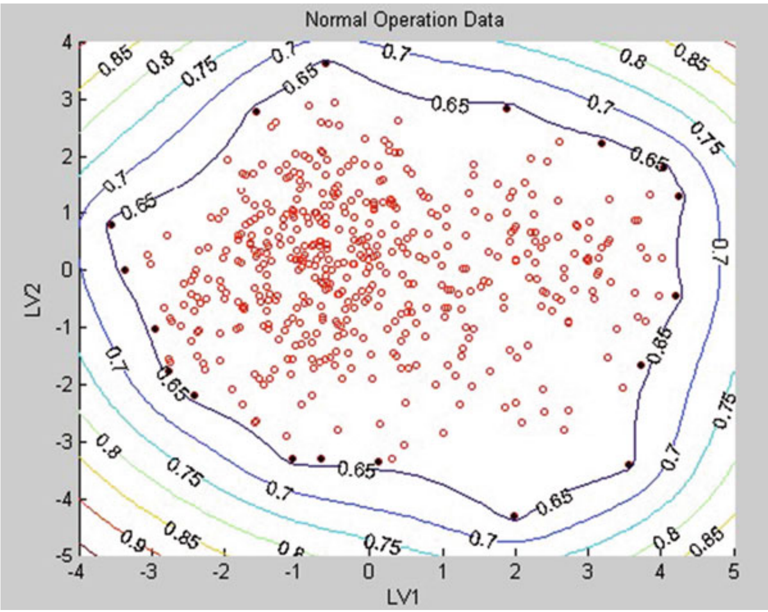

Fig. 4 Normal data boundary

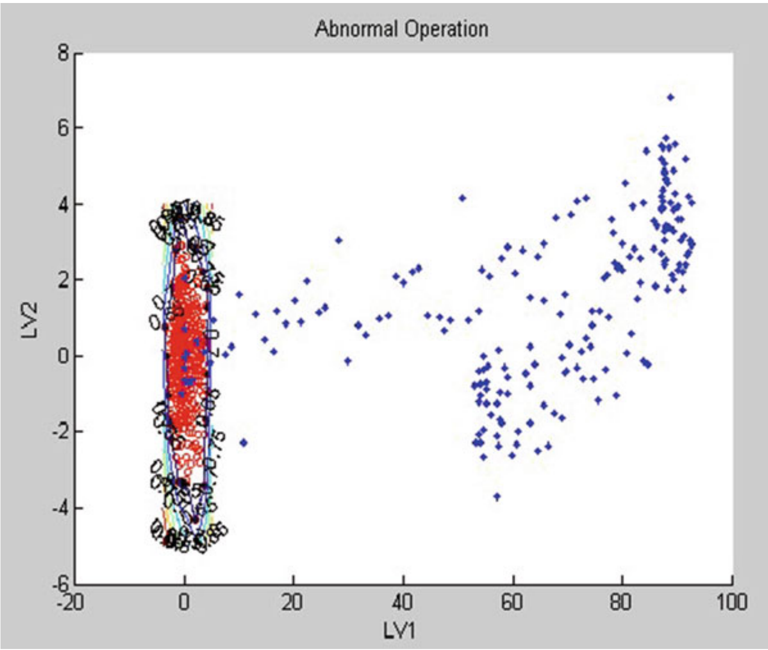

Fig. 5 Fault IDV (1) in monitoring space

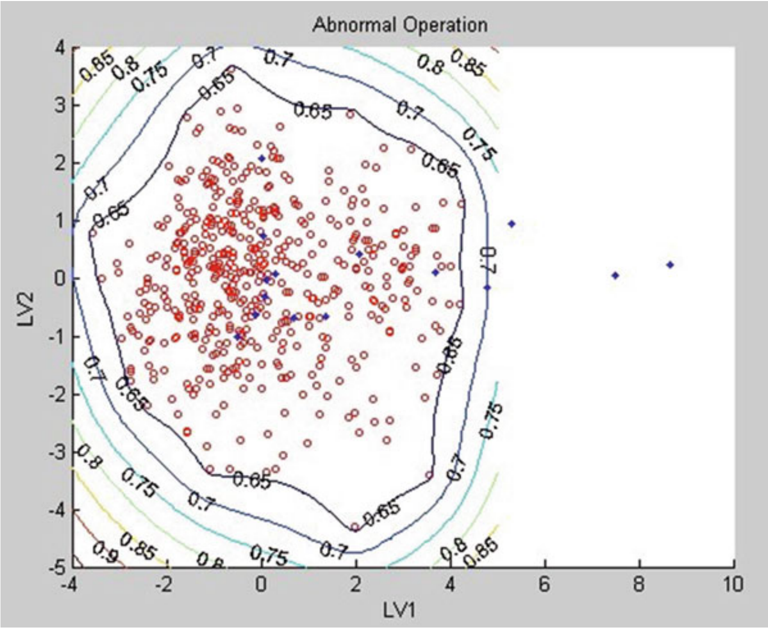

Fig. 6 Zoomed view of fault IDV (1)

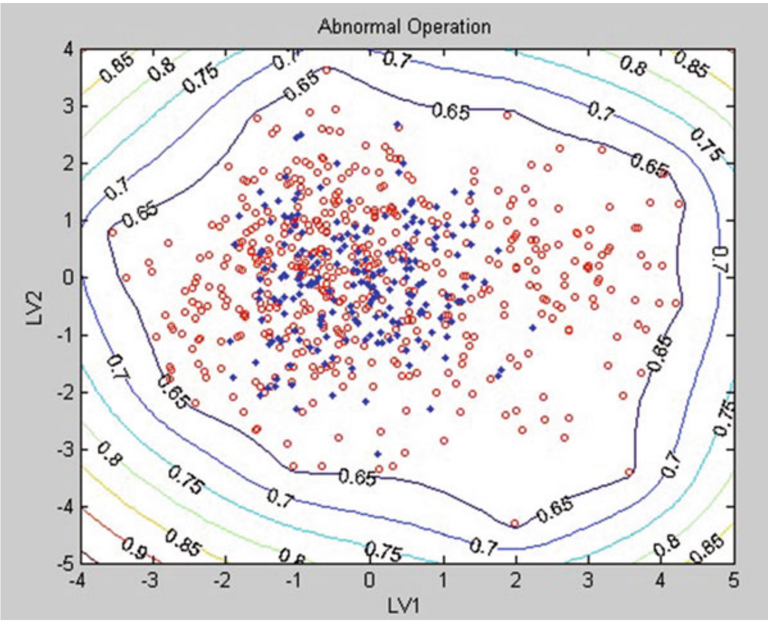

Fig. 7 Fault IDV (5) in monitoring space

Table 2 Fault detection results by different schemes

#	Directly related to quality	Detected by PLS	Detected by PCA
IDV (1)	Y	Y	Y
IDV (2)	Y	Y	Y
IDV (3)	N	N	N
IDV (4)	N	N	Y
IDV (5)	N	N	N
IDV (6)	Y	Y	Y
IDV (7)	Y	Y	Y
IDV (8)	Y	Y	Y
IDV (9)	N	N	N
IDV (10)	N	N	Y
IDV (11)	N	N	Y
IDV (12)	N	N	Y
IDV (13)	Y	Y	Y

3.3 Monitoring Results Analysis

When all the 13 independent faults are introduced into the TE process, it is indicated in Table 2 that the process monitoring scheme with PLS-SVDD can only detect the fault IDV (1–2), IDV (6–8) and IDV (13), while it is blind to IDV (3–5) and IDV (9–12).

After analyzing the different faults provided in Table 1, we find the fact that the 13 faults can be further divided into two groups based on their correlation with product quality variables, i.e. IDV (1–2), IDV (6–8) and IDV (13), which are closely related to the reaction, have direct influence on product quality G and thus could be identified by monitoring scheme. Yet IDV (3–5) and IDV (9–12), which are merely related to temperatures, have relatively low relationship with product quality and hence cannot be easily differentiated from normal operation data. So it could conclude that since PLS is extracting data information based on correlation between process variables and quality variables, it may less sensitive to process variation unrelated to quality variables.

In order for comparison, process monitoring scheme with PCA-SVDD is applied in TE process, since PCA extracts process variance, no matter whether the variation is related to product qualities. The comparison results are also shown in Table 2.

From Table 2, we know faults IDV (3), IDV (5) and IDV (9) cannot be detected by either method, which means such faults neither affect the quality variables, nor violate the monitoring space, thus may not use statistical tools for process monitoring.

Process monitoring with PCA-SVDD can detect the faults as long as there is variation in the process, even if such variation may not affect product qualities, like fault IDV (4) and IDV (10–12).

Although process monitoring with PLS-SVDD cannot detect the faults which have no direct effects to qualities, it can effectively detect the faults which have direct relation with the product qualities. Such characteristic builds an indispensable foundation in its application in various practical industries.

4 Conclusions

Multivariate statistical process monitoring scheme combining projection to latent spaces (PLS) and Support Vector Domain Description (SVDD) is able to directly monitor product qualities through process variables during industrial process regardless of data distribution. It is very advantageous in real industrial production where predicting product qualities remains highest consideration.

Meanwhile, such advantage is compromised due to its decomposition in quality variables, so this scheme is less sensitive to the fault which has no correlation with final quality variables. Thus, careful consideration and analysis about applicability of this method would be necessary.

Still, with its advantages of refraining from data distribution assumption and predicting the product qualities, process monitoring scheme with PLS-SVDD would be a very competitive process monitoring scheme in real industrial environment.

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The Signal Processing of Wharf Structure Health Monitoring Based on Wavelet Analysis

Xiao-bo Wang, Jue-long Li, Jian-chun Xing, and Li-qiang Xie

Abstract The importance of harbor wharf determines that we must grasp its health state in real time. First of all, this paper analyzes various harbor wharf damage forms, and builds its structure health monitoring system, then it points out the importance of signal processing in structural health monitoring. Wavelet analysis, as a new tool to data processing, with its advantages now is widely used in many fields. In this paper, the application of wavelet analysis in the harbor wharf structure is introduced, including signal denoising, signal compression and damage identification. Finally, this paper puts forward the research direction of wavelet analysis in structural health monitoring.

Keywords Harbor wharf • Signal processing • Structure health monitoring • Wavelet analysis

1 Introduction

Harbor wharf is an important water structure used for shipping dock, loading and unloading operations, and there are usually three forms: gravity wharf, sheet pile wharf and high pile wharf, respectively. Harbor wharf lies in the complicated external environment for a long time, and often bears great load, as time passes,

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this will lead to its durability deterioration, and its structure aging damaged, which greatly affect its life and safety. In addition, naval port wharf shoulders the responsibility of the logistics, and then their health state should be taken more seriously, so providing real time wharf health information has become a necessity.

When sheet pile wharf is under excess load, it is easy to produce large lever force, resulting in the fracture of the gusset plate pile rod. High pile wharf often uses cancelled structure, is also more sensitive to overloading, and it can cause large cracks and plastic deformation to steel structure. Bearing capacity of various wharfs is greatly weakened due to concrete corrosion caused by complex environmental factors, and above factors all can affect the safety of the structure (Huang Chang-hong and Wei Zhuo-bin 2009).

The rest of this paper is organized as follows: Sect. 2 constitutes the wharf structural health monitoring system and analyzes the importance of the data processing. Section 3 introduces the basic principles of the wavelet transform and singular analysis. Section 4 presents the application of wavelet analysis in wharf structure health monitoring. Section 5 concludes the paper.

2 The Constitution of Wharf Structure Health Monitoring System

2.1 Wharf Structure Health Monitoring System

Wharf structure health monitoring refers to the use of nondestructive sensing technology and structure characteristics of the system to achieve the purpose of monitoring the structural damage or degradation (Housner et al. 1997). The ideal health monitoring and damage detection technology should be able to find structural damage in the earlier time that damage appeared, and determine the time and location of the damage occurrence within the permission of sensor precision, in order to estimate the extent of damage and predict the remaining useful life of the structure. The ideal damage identification methods should have another important performance that the ability to distinguish the difference between the deviation caused by structure modeling and the deviation caused by the structural damage.

The long term health monitoring of the wharf structure is a kind of on line monitoring technology, which mainly includes the following aspects: sensing system, data acquisition and processing equipment, communication system, the monitoring center and alarm equipment.

The sensing system consists of the selection of perception component and the optimization of the sensor layout; data acquisition and processing equipment is in charge of data collection and preliminary processing; communication system is responsible for transmitting the collected data to the monitoring center for analysis and judgment, in order to assess the health status of the structure. If there is structural damage, the monitoring center will issue a warning signal, which drives alarm

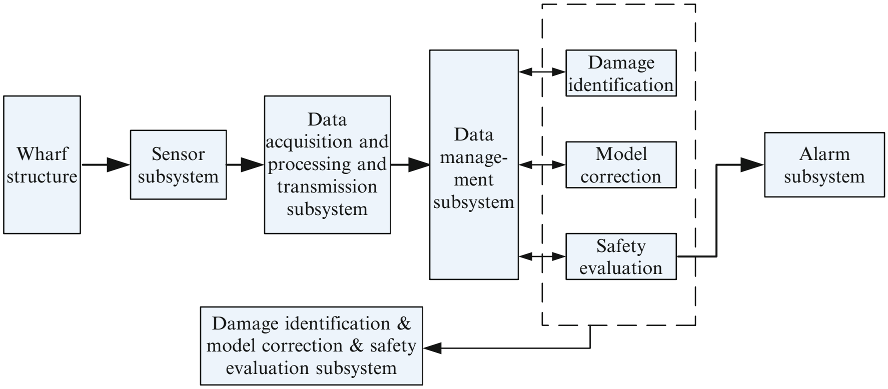

Fig. 1 Wharf structure health monitoring system

equipment to alarm, and at the same time provide maintenance recommendations (Li Hong-nan and Gao Dong-wei 2008).

Wharf structure health monitoring system is shown in Fig. 1:

2.2 *The Importance of Data Analysis*

Wharf structure health monitoring is to extract useful information from the detection signal, then know and analyze the structure. In structural health monitoring system, the signals collected from the scene, including displacement, strain, acceleration and environmental incentives.etc., which are collected from the different measuring points of the structure. When there is damage to structure, structure performance will change, and also the corresponding signal will change. Structural health monitoring system is to analyze the real time data which can characterize the changes of the structure, with which it can determine the injury time and damage location and analyze damage degree, so as to correctly evaluate the wharf structure health status.

As can be seen, the advantages and disadvantage of a wharf health monitoring system is mainly determined by the following three factors (Guo Jian and Sun Bing-nan 2005):

(a) The sensitivity and accuracy of the sensor, along with the optimized arrangement of sensor;
(b) The collection devices and the performance of data transmission;
(c) The ability to analyze and process test data.

From the current development perspective, the accuracy and sensitivity of the sensor is more and more high, intelligent sensor component with high performance and signal acquisition equipment is more and more widely applied in engineering

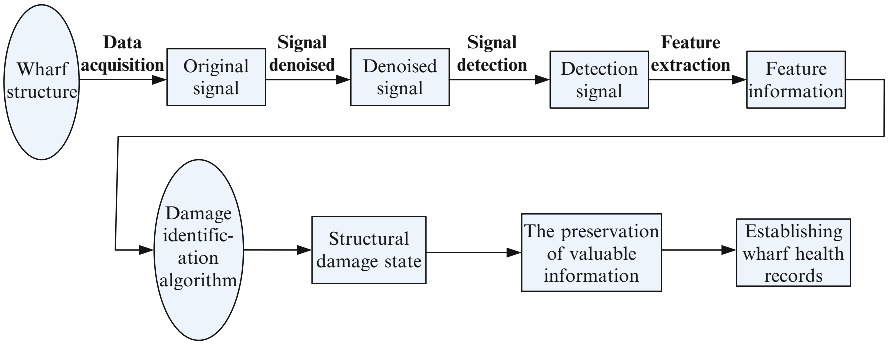

Fig. 2 Analysis process of wharf health monitoring

field (Ou Jin-ping 2004). So signal access is not a major problem. That whether we can use fewer sensors but get more information about the structure is determined by the optimized arrangement of sensor, which also determines the sensitivity of the test data to changes in the structural damage. The optimization problem is one of the major problems that need to be solved. Currently there are many researches in this field (Lim 1992). The assignment of analysis and processing of test data is to identify structural damage and assess wharf overall health condition, so the key problem in wharf health monitoring remains to be analysis and processing of test data.

In the process of signal analysis and processing, first of all, denoise the signal, eliminating the noise interference from various aspects in signal, and then analyze the signal, combined with damage identification algorithm to identify damage classification and determine the current wharf health status. At last, combined with expert system to accomplish the assessment of wharf health state and save valuable test data, and then establish wharf health files.

The process is shown as Fig. 2, which involves the signal denoising, signal detection, feature extraction and signal compression technology, the wavelet analysis theory mentioned below has its unique advantages in the above signal processing.

3 The Basic Principles of the Wavelet Transform and Singular Analysis

The traditional Fourier transform is a kind of pure frequency analysis, which has no local characteristics in the time domain, to some extent, the later short time Fourier transform overcomes the flaw that traditional Fourier has no ability for the local analysis, but it has its own insurmountable shortage, that is, once the window function is determined, the time frequency width is unchanged, so the short time Fourier transformation is a method of single resolution in essence, if you want to alter resolution, you must reselect the window function. In 1984, the French geophysicist J. Morlet introduced the concept of Wavelet transform to decompose Wavelet, and along with the French theoretical physicist A. Grassmann put forward a system theory that a signal is expanded according to a stretch shift system which is composed of a certain function, which is the continuous wavelet transform. Wavelet analysis provides a flexible time frequency window, and the window can widen at low frequencies and the window can narrow at high frequencies. It is also known as mathematical microscope of analysis signal, especially suitable for the time frequency analysis to the signal containing unsteady components, widely applied in the engineering field (Cheng Li-zhi et al. 2004).

The realization of wavelet transform includes two kinds: the continuous wavelet transform and the discrete wavelet transform.

3.1 The Principle of Continuous Wavelet Transform

For any signal function meeting $f(x) \in L^2(R)$, its continuous wavelet transform is defined as

$$W_f\ (a,b) = \langle f(x), \psi_{a,b}(x) \rangle = \frac{1}{\sqrt{a}} \int_{-\infty}^{+\infty} f(x) \psi \left(\frac{x-b}{a} \right) dx \tag{1}$$

where a and b equal dilation and translation parameters, respectively, both are real numbers and a must be positive. $\psi(x)$ is a square integrable and piece wise continuous function, called the mother wavelet; the mother wavelet should satisfy an admissibility condition to ensure existence of the inverse wavelet transform such as

$$C_\psi = \int_{-\infty}^{+\infty} \frac{\left| F_\psi\ (\omega) \right|^2}{|\omega|} d\omega < \omega \tag{2}$$

where $F_\psi(\omega)$ is the Fourier transformation of $\psi(x)$.

$\psi_{a,b}(x)$ is wavelet function family which is produced by the scale extension and time shifting of the mother wavelet $\psi(x)$, defined as

$$\psi_{a,b}(x) = \frac{1}{\sqrt{|a|}} \psi \left(\frac{x-b}{a} \right) \tag{3}$$

The signal $f(x)$ may be reconstructed by inverse wavelet transform of $W_f(a,b)$ as defined by

$$f(x) = \frac{1}{C_\psi} \int_{-\infty}^{+\infty} \int_{-\infty}^{+\infty} W_f\ (a,b)\, \psi \left(\frac{t-b}{a} \right) \frac{1}{a^2} dadb \tag{4}$$

The information of continuous wavelet transform coefficient $W_f(a,b)$ is redundant. However, discrete wavelet transform is usually used in engineering field.

3.2 The Principle of Discrete Wavelet Transform

In practical signal processing a discrete version of wavelet transform is often employed by discretizing the dilation parameter a and the translation parameter b. In fact, the procedure becomes high efficiency if dyadic values of a and b are used, i.e.,

$$a = 2^j, b = k2^j \quad j, k \in Z$$

For any signal function $f(x) \in L^2(R)$, its corresponding discrete wavelet function is defined as,

$$\begin{aligned} W_f(j,k) &= \langle f(x), \psi_{j,k}(x) \rangle = \int_{-\infty}^{+\infty} f(x)\psi_{j,k}(x)dx \\ &= 2^{-\frac{j}{2}} \int_{-\infty}^{+\infty} f(x)\psi\left(2^{-j}x - k\right)dx \end{aligned} \tag{5}$$

where j is scale factor and k is shift factor.

For some special $\psi(x)$, its corresponding discrete wavelets $\psi_{j,k}(x)$ is given,

$$\psi_{j,k}(x) = 2^{\frac{j}{2}}\psi\left(2^j x - k\right) \tag{6}$$

which constitutes an orthonormal basis of $L^2(R)$.

The original signal function can be reconstructed by the formula below:

$$f(t) = \sum_{k \in Z} \sum_{j \in Z} W_f(j,k)\, \omega_{j,k}(x) \tag{7}$$

Theory can be proved that when continuous wavelet transform converts to discrete wavelet transform, the basic information of the signal will not be lost. On the contrary, because of the orthogonality of the wavelet base function, it makes the association hard to eliminate caused by redundancy between two points in the wavelet space. At the same time, because of the orthogonality, it makes the calculated error smaller, and the time frequency function of transform result can better reflect the nature of the signal itself, so the discrete wavelet transform is widely used in engineering field (Zhang De-feng 2012).

3.3 The Singular Analysis

The mutation point of the transient signals often contains very important fault information, such as structural damage, reinforced fracture, mechanical failure, ECG abnormalities and so on. Although their background is different, they correspond to some kind of mutant forms of detecting signal; this is the singularity analysis of signal. Wavelet transform has local characteristic in time domain and frequency domain, and it has "zoom" characteristics, so it is very effective to determine the position of signal singularity (Mallat and Hwang 1992). Signal mutation points in wavelet analysis often correspond to the extreme points of the wavelet transform modulus, and the size of the signal singularity is corresponding to wavelet transform modulus size (Mallat 1991). Therefore, it is very meaningful that wavelet transform is applied to describe the transient characteristics of the signal.

4 The Application of Wavelet Analysis in Wharf Structure Health Monitoring

4.1 Signal Noise Reduction

Measurement noise is ubiquitous in the signal data acquisition, noise is mainly caused by thermal electromagnetic effect of signal acquisition instrument and signal transmission device, the noise mostly belong to random white noise. When the degree of noise pollution is too large, it will increase the difficulty in identifying structural damage, so we should denoise the collected signal first. The traditional noise reduction methods mainly include linear filtering method and nonlinear filtering method. But after signal conversion, the entropy increases, the nonstationary characteristics of the signal cannot be characterized and the signal correlation cannot be got. The wavelet analysis brings new time frequency analysis technology to signal noise reduction, with the characteristics of multiscale resolution to correlation, compared with traditional filtering techniques, it has better effect in signal noise reduction (Zhang De-feng 2012; Smith et al. 2004).

The effect of wavelet analysis used for signal noise reduction is illustrated by damage displacement signal, Fig. 3a shows the damage identification original signal, adding white noise into the signal, then we get containing noise signal shown in Fig. 3b, using wavelet threshold noise reduction method to cope with the noisy signal, get the signal shown in Fig. 3c. Obviously, what we can see is the white noise lessens by a large margin, so it is effective to denoise signal with the wavelet.

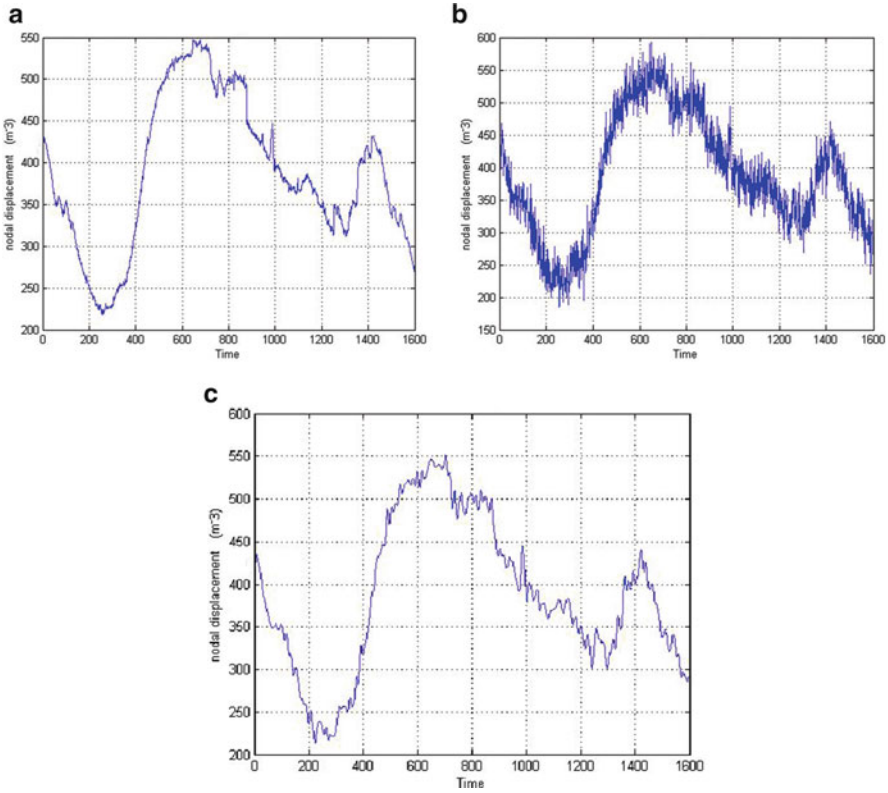

Fig. 3 Signal noise reduction effect diagram. (**a**) Initial signal. (**b**) Noisy signal. (**c**) Denoised signal

4.2 Signal Compression

In wharf structural health monitoring system, amounts of test data is sent to the data processing center constantly. The wireless sensor network develops so rapidly that it is widely applied to the structural health monitoring communication system. The data is so massive that it is not suitable for wireless sensor networks to transfer data, and it is inconvenient for data processing center to store and manage data. It can not only largely relieve the pressure of wireless sensor network transmission by using efficient signal compression technology, but also reduce the requirements of data storage device. At the same time, it can be conducive to the processing and management of data signal, and establish the wharf healthy record expediently. The basic requirement of signal compression is without loss information of the original signal. There are many signal compression methods, the wavelet method is one of them.

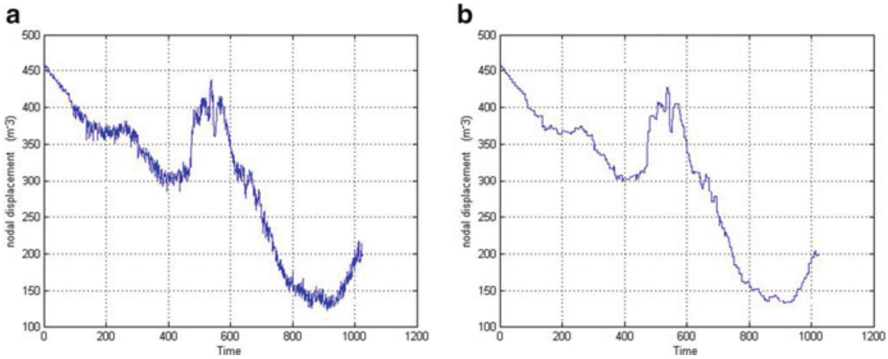

Fig. 4 Signal compression effect diagram. (**a**) Initial signal. (**b**) Compressed signal

The effect of wavelet analysis used for signal compression is illustrated by acceleration signal. Figure 4a shows a collected displacement signal, compress the signal using wavelet method and get the signal shown in Fig. 4b, what we can see is the mainly information of the original signal is reserved, and respond the changing trends of original signal well, so it is also effective to compress signal with the wavelet.

4.3 The Engineering Application of Wavelet Analysis in Wharf Structure Health Monitoring

Harbor wharf structural damage includes flat slab cracks due to overload, plastic deformation of the steel bar, fracture sheet pile wharf lever, etc. Wavelet analysis can be used to detect small changes of the vibration signal caused by structural damage, so as to realize the early warning of damage (Mallat and Hwang 1992). By wavelet analysis for time acceleration signal of damaged structure, the time of structural damage occurrence can be got. Papers (Guo Jian et al. 2006) have described in detail, here we mainly carry on location analysis of structural damage.

Cantilever beam structure can be seen everywhere in the harbor wharf, numerical simulation of cantilever beam structural damage is built to illustrate warning effect of applying wavelet analysis to structural damage detection. The reduced model of cantilever in proportion is shown in Fig. 5.

The length, width and height of simplified cantilever beam is 6.0 m, 0.3 m and 0.6 m, respectively, evenly take 300 nodes in cantilever beam, cracks occur at node 60, and F = 3.0 kN is placed at the structural free end. Its deformation simulation is shown in Fig. 6, compared with the vertical displacement without damage, the result is shown as Fig. 7. We found that the displacement of the two curves almost coincide, so displacement curve alone cannot identify the damage location.

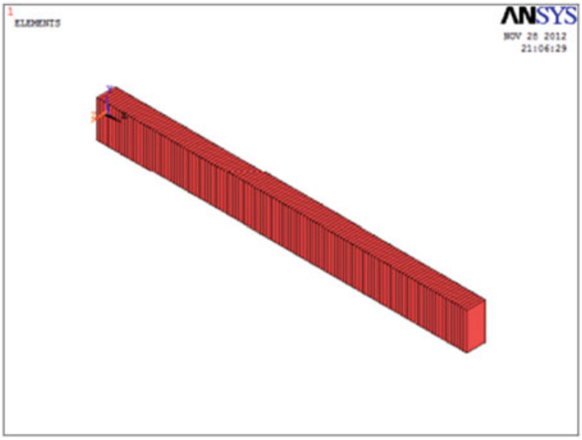

Fig. 5 The cantilever beam used for numerical simulation

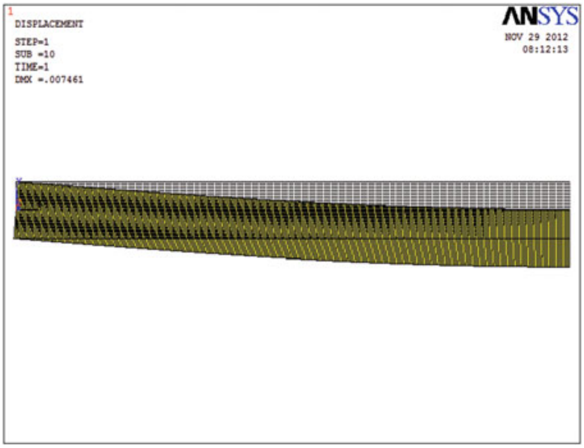

Fig. 6 The contrast before and after structure stress

Biorthogonal wavelet is used for discrete wavelet transform of the displacement curve with damage, its detailed signals at 1 scale is shown in Fig. 8. As can be seen from the figure, when the structure is damaged, detailed signals in structural damage appears obvious mutation, which can be used to identify the location of the damage. Fluctuations in the tail of the detailed signals is due to not taking smooth processing to signal, Gibbs phenomenon happened (Zhang Xian-da 2001), so damage location can be located by using wavelet transform.

5 Conclusion and Prospect

Since the French geophysicist put forward the true meaningful wavelet transform in 1984, wavelet analysis has been widely applied to many subjects, and shows a strong advantage in signal processing. Considering operation and maintenance of harbor

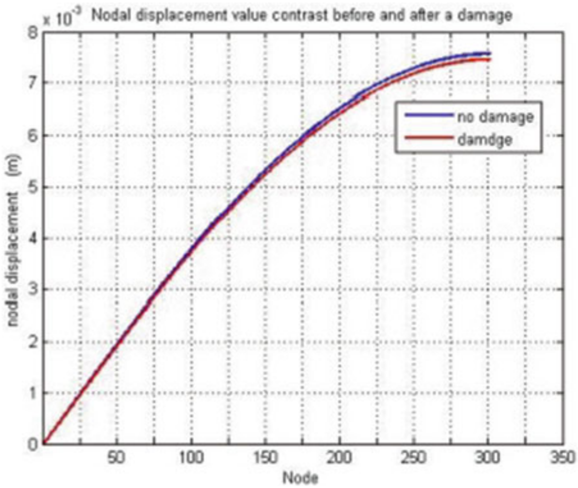

Fig. 7 Nodal displacement value contrast before and after damage

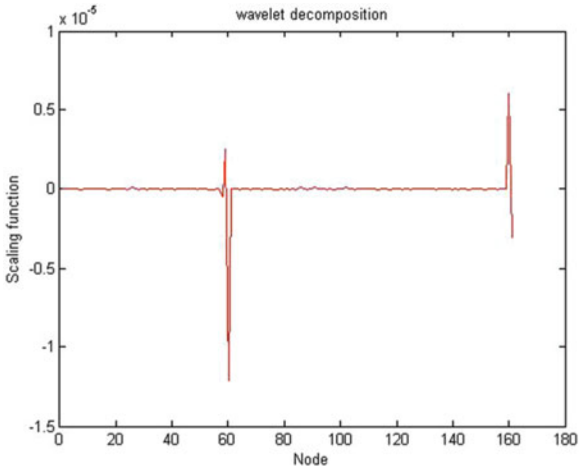

Fig. 8 The wavelet decomposition to the damage structure

wharf, obtaining its real time health information has become a necessity. Combining wharf own characteristics, wavelet analysis is applied into the structural health monitoring, including signal noise reduction, signal compression, signal detection and feature extraction. The good results displays that wavelet analysis can be widely used in wharf structural health monitoring.

Wavelet analysis has a great advantage in processing the test data of the structure, nevertheless, the wavelet analysis method has some imperfections, which need us to continue to study:

1. The premise of the wavelet analysis is to obtain a sufficient number of valuable structural signal, the issue of sensors optimal placement involved is still a focus of our research;

2. With ambient excitation structural damage identification based on wavelet analysis is a research direction of further development of wavelet in structural health monitoring;
3. Research the effect of external interference to structural vibration signals, and separate the signal change caused by environmental changes correctly is a challenge to wavelet analysis;
4. Most studies focus on sample model examples, and there is no such a good example of large structure test or actual structure validation.

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Studies of Balance and Simulation of Gearbox Assembly Line Based on Flexsim Software

Hong-ying Shan, Li-bin Zhang, Xin-zhao Gao, and Xiang-bo Li

Abstract The balance of production line would definitely help the workers and facilities increase the operational efficiency. Computer modeling and simulation can shorten the R&D cycle, predict and optimize the layout of production line. After analyzing the gearbox assembly line and drawing flow charts, we can work out a simulation model and then use Flexsim software and heuristic balancing algorithm to make gearbox assembly line more reasonable. By comparing the balance of gearbox assembly line. From the comparison of the indicators before and after simulation and the utilization of the station, we can firmly draw the conclusion that the transmission efficiency of assembly line production is significantly improved.

Keywords Balance • Flexsim • Gearbox assembly line • Simulation

1 Introduction

Obviously, the inconsistency of takt time in each station on the assembly line could lead to a bottleneck which will waste labor hours waiting for workpieces and cause the accumulation of WIP (Zhang Zheng-chao and Liu Yu 2010). By measuring the operating time of each process, analyzing the process of the assembly line as well as rescheduling the process flow on the basis of specific process priorities, we can balance the work load and increase the utilization of equipment and staff

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(Yu Zhao-qin 2008; Liu Guang-fu and Li Miao 2008). When the station of the assembly line generate idle station and line idle duo to the differences between operation time, we can change the content of process activity, combine some processes or change the number of workers.

Flexsim, the first simulation software in the world, which integrates C++ IDE and compiler in the graphical modeling environment, is now being widely used because of its simple model, high visibility and clarity (Bao Si-qintana et al. 2008). Based on OpenGL, the 3D animation effects of Flexsim are so vivid that they can provide visual demonstration effects of the model to users. While the early developed simulation softwares such as Arena, Promodel and Witness do not eqiup the function of 3D virtual simulation. Automap has wire-frame model based on 3D virtual technology, but it fails to reflect the effects of 3D simulation (Hu Jing et al. 2009). In addition, date can be easily called and storage which is conducive to the unity of modeling data formats. Therefore, Flexsim software can be widely used among the fields of line balancing, selection of distribution center and the distribution between inventory and logistics (Li Gang et al. 2008).

2 Methodology

2.1 *Balancing Analysis and the Improvement of Gearbox Assembly Line*

Gearbox assembly line includes manual gearbox assembly line and automatic transmission assembly line. It consists of convey roller, tray, flip machine, gasket selection measuring machine, push mounting, seal leak testing machine, torque measuring machine, noise measuring machine, fixture, aids, etc. The common assembly line forms are linear assembly line, U-type line loop-type and L-type line. In this paper, take the 14-station U-transmission assembly line as an example and the overall layout is shown in Fig. 1:

This transmission assembly line had three main problems: First, a large number of WIP was backlogged because the operating time of Press-fit two-axis is longer than other processes. Second, assembly operations cover a longer time lead to clutch-packing appeared idle. Third, the buffer area is so large that forklifts cannot be able to move normally and the normal operations of the following processes were delayed. By measuring the operating time, we drew the time-speed graphic of each station (As it shows in Fig. 2) (Zhou Xiao-li and Cao Zhen-xi 2008; Zhu Tao and Guo Liang 2011).

Accord to the analysis of speed chart and the balance of the production line, we can get the conclusion that the tenth station (cover assembly) used the longest time. So it was the bottleneck. Meanwhile, the second position (hang to the island)

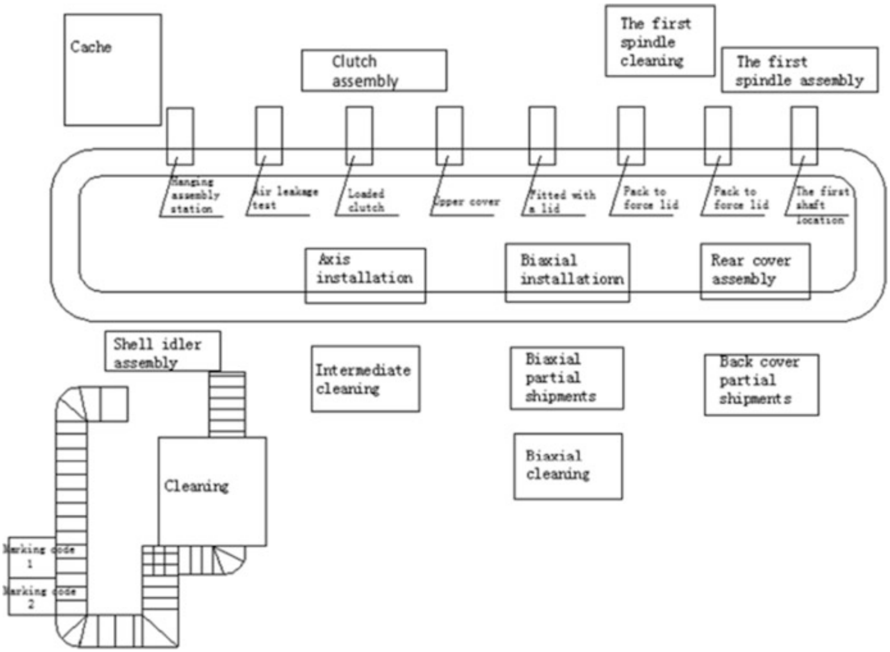
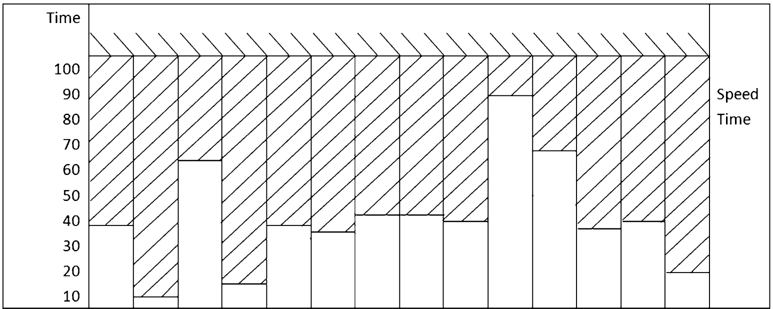


Fig. 1 Layout of U-gearbox assembly line



Name	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
Personnel	1	1	1	1	1	1	1	1	1	1	1	1	1	1	14 人
Time	40	8	64	15	41	36	48	48	43	90	69	41	47	23	614

Fig. 2 Each station's operating time before balance

used the shortest time (only 8 min). Therefore, we can lighten the workload of the workers who press-fit two-axis, add the number of workers who take part in covering assembly, eliminate the cache area to improve the assembly line (Su Chun and Sun Yu 2009; Xia Xiu-fang et al. 2009).

Table 1 Correspondence between entities and the system of assembly plant

No.	System name	Name of entity	No.	System name	Name of entity
1	Generator	Source1	11	8 Station	Processor11
2	1 Station	Processor2	12	9 Station	Processor12
3	Buffer	Queue3	13	Buffer	Queue13
4	2 Station	Processor4	14	10 Station	Processor14
5	Buffer	Queue5	15	11 Station	Processor15
6	3 Station	Processor6	16	12 Station	Processor16
7	4 Station	Processor7	17	13 Station	Processor17
8	5 Station	Processor8	18	14 Station	Processor18
9	6 Station	Processor9	19	Absorber	Sink19
10	7 Station	Processor10			

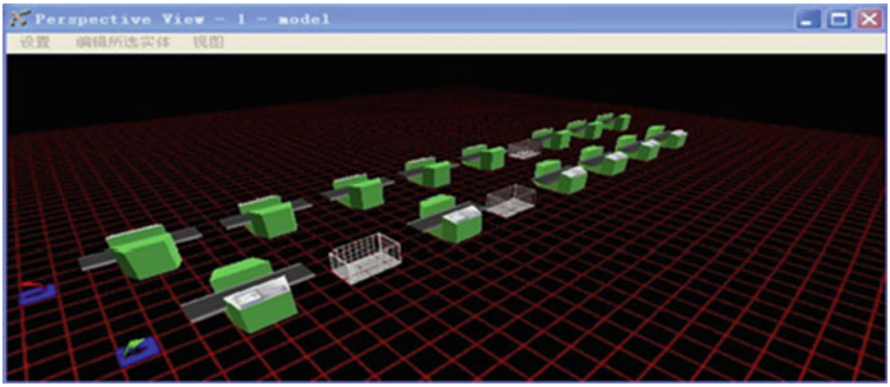


Fig. 3 Modeling and simulation figure of gearbox assembly line

2.2 *Modeling and Simulation of Gearbox Assembly Line Based on Flexsim Software*

We used the station of assembly line as the basic unit to build the model and analyzed the relationship between entities and the transmission assembly line system. As it shows in Table 1:

We established a basic model after setting the processing time of each station, the number of operators, operating rules and handling conditions after processing (Jiang Yan et al. 2011) (As it shows in Fig. 3).

By analyzing the utilization of the processing time and the idle time of each station, we drew the map of each station processor's utilization (As it shows in Fig. 4).

Comparing to the utilization of each station processor, we can clearly saw from the figure that the tenth station's processing time accounted for the ratio of the total time 98.7 %, which reached the highest point of the graphic. However, the second station's processing time only accounted for 9.2 % of total time and won the lowest

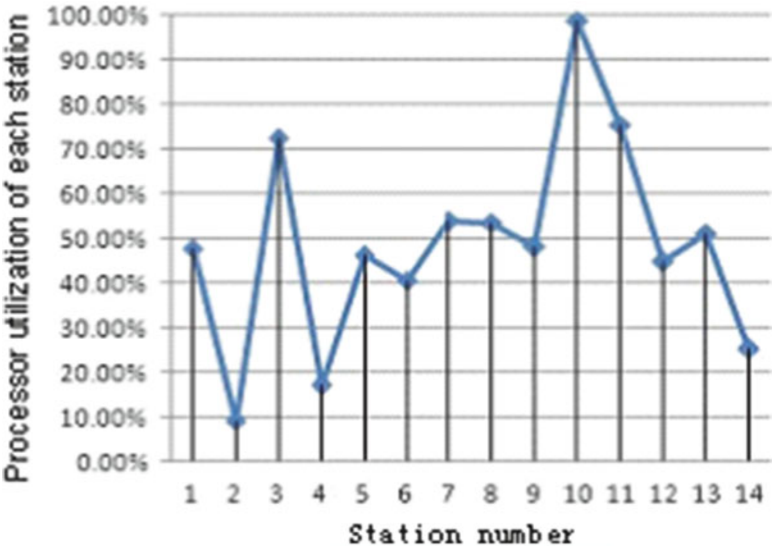
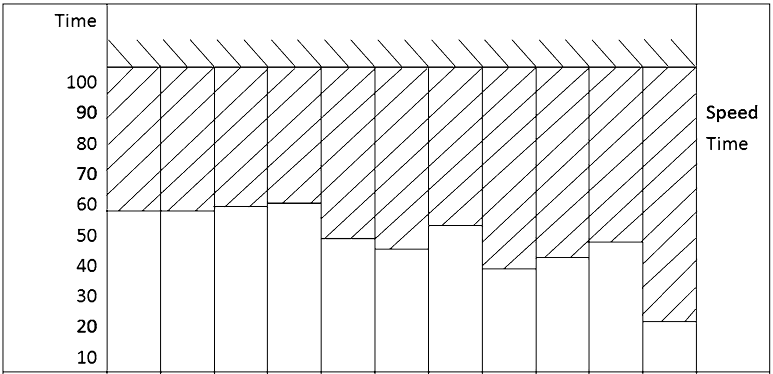


Fig. 4 The utilization of each station processor before balance

point of the figure. Most other stations' processing time accounted for 17–55 % of the total time and lower than 60 %. From the viewpoint of idleness, the tenth station's free rate was 1.3 %, while the second station's free rate was 90.8 %, and most other stations' free rates were 44 % or more. Therefore, we can conclude that the load of each station was far less than balance (Gao Huan-ming et al. 2010).

2.3 Simulation of the Assembly Line After Improvement

According to heuristic balancing algorithm, we should assign key stations and those have more subsequent operations first. Then we listed the table of the leading elements of operations. Starting from the first operational element of the assembly precedence graph, we could allocate operational elements to this station as many as possible on the premise of satisfying the order of precedence graph. First, we calculated the remaining time of this station. If it had remained time, we should not stop allocating until there were no operating elements. The distribution of the station finished. Then we did the same work as we had done in the first station and then the third, the fourth till all working elements were distributed. Lastly, we compared the processing time with the takt time to even or approximate each station's operating time and idle time so that we could eliminate the imbalance as much as possible (Zheng Geng-zao et al. 2010; Hu Luo-ke et al. 2012).



Name	1	2	3	4	5	6	7	8	9	10	11	Total
Personnel	1	1	1	1	1	2	2	1	1	1	1	13 人
Time	56	56	57	58	48	45	50	36	43	47	23	535

Fig. 5 The speed chart of gearbox assembly line after balance

We resettled the work time after balance and parameters of each processor and then compiled and run the simulation model. We now get the new speed chart as it shows in Fig. 5 (He Hai-tao 2009):

From the analysis of speed chart and the assembly line, we can point out that the time of each station was more balance than before. Therefore, we can firmly draw the conclusion that the assembly line is improved effectively and efficiently. Median work is now reduced from 14 to 11. The second station's processing time accounts for 94.6 % of the total time ratio, the idle time accounts for 5.4 % of the total time ratio. Therefore, the number of the stations and idle time are reduced, human resources are saved and the efficiency is improved.

2.4 Comparison of Simulation Before and After Balancing

After optimization, the number of assembly stations is reduced three which would contribute to increase the areas of assembly workshop. Cycle time is decreased from 90 to 58 s, so the outputs and the productivity of the assembly workshop are greatly enhanced and the production costs are cut down dramatically. The workshop's balance rate increases from 48.73 to 83.86 % and balance delay rate declines from 51.27 to 16.14 %, which mean that the stations' idle time and work time succeed to achieve a high balance.

The following is the utilization graph of each station after balance (As it shows in Fig. 6).

We can assert from the Fig. 6 that broken line represent each station's utilization do not hold a too high or too low position, which indicates that each station's load in the assembly line reaches balance.

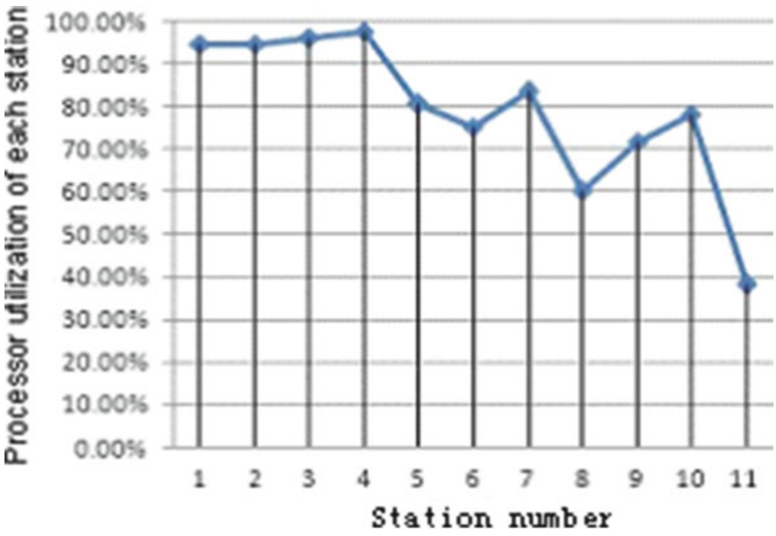


Fig. 6 Utilization graph of each station after balance

3 Conclusion

1. We applied Flexsim software to model and simulate U-gearbox assembly line, run the model, got the results and compared the differences before and after simulation. It shows that this method is convenient, simple and practical for modeling and can be used in the area of optimization and adjustment of the layout of the assembly line station.
2. Using heuristic and balancing algorithm to balance gearbox assembly line, we reduced the number of station, made the uneven load balanced and improved efficiency.

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The Maturity Evaluation of Technology Application for Guilin National Tourism Comprehensive Reforming Zone

Fu-xing Zhang, Jun Li, Wen-zhong Du, and Meng-yi Qiu

Abstract This article views science and technology support for Guilin national tourism comprehensive reforming zone as the core. According to the law of tourism development stages and based on literature study and field research, it builds an index evaluation system for the technology need of reforming zone, evaluates the current development stage of Guilin tourism by the means of grey comprehensive evaluation method, analysis the stages of development and competitive elements gap of Guilin tourism based on the evaluation result, and provides strategies to improve the corresponding strategy, which is used for relevant departments to implement the strategy of "Building a world-class tourist destination of Guilin, building beautiful Guilin".

Keywords Comprehensive reform • Guilin tourism • Maturity evaluation • Pilot zone • Tech requirements

1 Introduction

With the rise of the domestic mass tourism, tourism popularity of information technology and tourism consumer requirements continue to increase, China's tourism industry facing institutional mechanism is not perfect, tourism product similarity, alternative high and low value-added multiple pressures, making the tourism industry transformation and upgrading imminent (Haemoon et al. 2009). Guilin is known for its unique cultural advantages of natural resources and landscape enjoys brand reputation, the first to be classified as National Tourism comprehensive reform pilot area, the effectiveness of its construction will be the national tourism

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industry to upgrade direct and lasting impact. The development of tourism with the progress of science and technology and tourism increasing consumer demand and is sustainable development, to analyze and identify the law of development of the tourism industry from the impact of technology on the tourism industry, not only can improve the development of tourism in this region understanding of the law, but also be able to evaluate, predict the development of other parts of the tourism industry, tourism management decision-making reference for the relevant departments.

2 The Guilin Tourism Development Maturity Assessment Index System

2.1 Tourism Development Stages

The development of modern tourism with the constant discovery, invention and application of science and technology open and integrated evolutionary process (Wang Chao-Hung 2004). In accordance with the different levels of integration of science and technology in the tourism development process content and application level, tourism development stage is divided into: single stores decentralized, diversified business, organizational form of large-scale, wisdom travel as cloud computing integration and Innovation globalization five stages, as shown in Fig. 1: the development of the tourism industry is a step-by-step progression, and the process is rising.

2.2 Tourism Development Maturity Evaluation Index System Analysis

This paper argues that, with the support of science and technology as the core of tourism development maturity evaluation index system is a multi-factor and a complex system of multi-level (Zhang Ya-ming et al. 2009). According to the basic principles and methods of system evaluation, combined with the actual construction of pilot area of scientific and technological needs, we build tourism investment in science and technology → achievements transformation → output use the main line. Through university employment, introduction of talents growing travel technology services team, to increase government finance and corporate income invested in R&D funding efforts, we continue to promote the construction of the test area the context of increased tourism and increased tourism revenue and regional economic coordinated development of comprehensive evaluation index system.

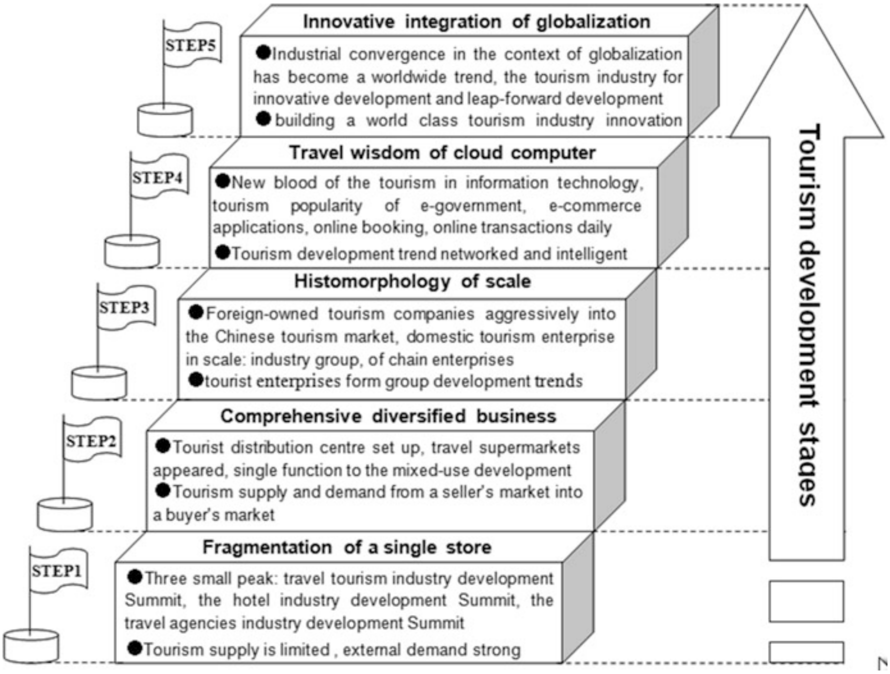


Fig. 1 Stage division of tourism development

2.3 *The Development of Tourism Maturity Evaluation Model*

Based on the above analysis, the use of critical success factors method to identify the key factors that affect the Guilin tourism development maturity, and then use AHP Analytic Hierarchy Process hierarchical division of the key factors and determine the weight of each factor (Zeng Qi Jie and Lu Li 2012). The specific results are shown in Table 1 shows.

3 Guilin Tourism Stage of Development Maturity Evaluation

Tourism development is moving in the direction of the wisdom of tourism in the smart city development mode, to meet the needs of tourism consumers increasingly novelty ANGEL divergent travel consumer demand. The development of tourism stage maturity refers to the tourism industry with respecting to the state of development of the tourist consumer demand, reflecting the degree of experience brought about by the development of the tourism industry to meet the target with respect to tourism consumers. Based on the requirements of gray multi-level index

Table 1 Maturity evaluation model of tourism development system

One level indicators	Two level indicators	Three level indicators	Weight
A_1 Tourism economic system (0.1205)	B_1 Urban population and economy (0.0311)	C_1 Total population of Guilin	0.0039
		C_2 Annual population increase	0.0115
		…	…
	B_2 Tourism economic (0.0768)	C_7 Year total number of tourism	0.0202
		C_8 Year increase of Tourists	0.0089
	…	…	…
A_2 Tourism infrastructure construction (0.2349)	B_4 Tourist reception capacity (0.1513)	C_{19} Reception capacity	0.0586
		C_{20} Increase in capacity	0.0256
		…	…
	B_5 Construction of tourism investment (0.0635)	C_{22} Investment in tourism facilities	0.0039
		C_{23} Rate of tourism facilities investment	0.0071
		…	…
	B_6 Tourism promotion investment (0.0200)	C_{27} Advertising investment	0.0019
		C28 Rate of advertising investment	0.0032
		…	…
A_3 Tourism industry competitiveness (0.0408)	B_7 Per capita indicators of competitiveness	C_{31} Per capita GDP	0.0051
		C_{32} Per capita tourist spending	0.0051
	B_8 Competitiveness indicators	C_{33} Residents of tourism	0.0050
		C_{34} Tourism ratio of revenue to GDP	0.0091
		…	…
A_4 Tourism technology I-o (0.5253)	B_9 Researcher indicators (0.2330)	C_{36} Fully employed researchers	0.0509
		C_{37} Number of graduate researchers	0.0443
		…	…
	B_{10} Research funding indicator (0.2035)	C_{41} Government funding for R&D	0.0124
		C_{42} The rate of government funding for R&D	0.0114
		…	…

(continued)

Table 1 (continued)

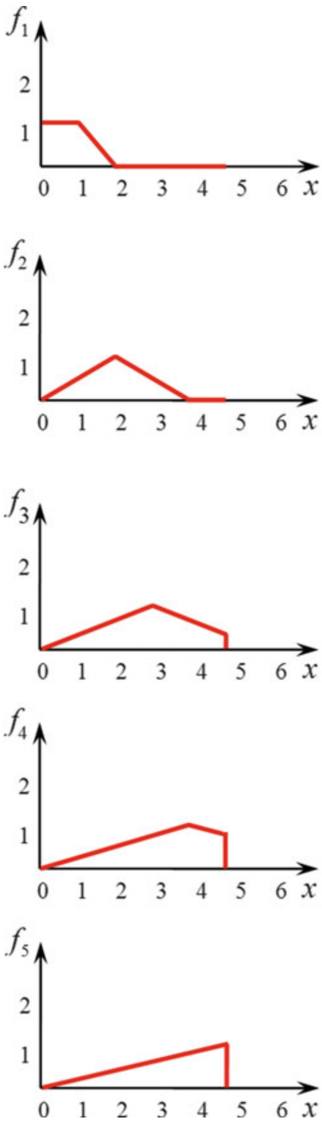
One level indicators	Two level indicators	Three level indicators	Weight
	B_{11} Scientific research indicators (0.0889)	C_{49} R&D total investment	0.0183
		C_{50} R&D ratio of investment to GDP	0.0084
		...	...
A_5 Tourism ecology environmental protection (0.0785)	B_{12} Urban garden greening (0.0082)	C_{54} Urban green area	0.0013
		C_{55} Annual gardening area increased	0.0023
		...	...
	B_{13} Tourism ecological environment (0.0500)	C_{58} Tourism ecology environmental capacity	0.0168
		C_{59} Annual environmental capacity increased	0.0045
		...	...
	B_{14} Tourist destinations of pollutants (0.0203)	...	...
		C_{67} Pollutant processing rate	0.0013
		C_{68} Units visitor volume of pollutants	0.0024

comprehensive evaluation method, Guilin tourism in which tourism development stage models evaluation, the results are as follows.

3.1 Guilin Tourism Stage Evaluation Determining the Weights

In this paper, Guilin tourism stage of development as the research object (denoted by X), gray multi-level analysis to determine the index weight, combined with the previous list of indicators for sorting (Fig. 2). Results can be obtained:

1. an assessment of the set of indicators and relative weight vector:
   (a) indicators collection: $U_A = \{A_1,A_2,A_3,A_4,A_5\}$
   (b) weight vector: $W_A = [0.1205,0.2349,0.0408,0.5253,0.0785]$
2. two assessment indicators of collection and relative weight vectors:
   (a) the collection of indicators:$U_{A1} = \{B_1,B_2,B_3\}$;$U_{A1} = \{B_4,B_5,B_6\}$;$U_{A1} = \{B_7,B_8\}$;$U_{A1} = \{B_9,B_{10},B_{11}\}$;$U_{A1} = \{B_{12},B_{13},B_{14}\}$
   (b) weight vector: $W_{A1} = [0.2583,0.6370,0.1047]$; $W_{A2} = [0.6442,0.2706,0.0852]$; $W_{A3} = [0.2500,0.7500]$; $W_{A4} = [0.4434,0.3874,0.1692]$; $W_{A5} = [0.1047,0.6370,0.2583]$



$$f_1(d_{ip}) = \begin{cases} 1 & d_{ip} \in [0,1] \\ (2 - d_{ip})/1 & d_{ip} \in [1,2] \\ 0 & d_{ip} \notin [0,2] \end{cases}$$

$$f_2(d_{ip}) = \begin{cases} d_{ip}/2 & d_{ip} \in [0,2] \\ (4 - d_{ip})/2 & d_{ip} \in [2,4] \\ 0 & d_{ip} \notin [0,4] \end{cases}$$

$$f_3(d_{ip}) = \begin{cases} d_{ip}/3 & d_{ip} \in [0,3] \\ (6 - d_{ip})/3 & d_{ip} \in [3,6] \\ 0 & d_{ip} \notin [0,6] \end{cases}$$

$$f_4(d_{ip}) = \begin{cases} d_{ip}/4 & d_{ip} \in [0,4] \\ (8 - d_{ip})/4 & d_{ip} \in [4,8] \\ 0 & d_{ip} \notin [0,8] \end{cases}$$

$$f_5(d_{ip}) = \begin{cases} d_{ip}/5 & d_{ip} \in [0,5] \\ 1 & d_{ip} \in [5,\infty] \\ 0 & d_{ip} \notin [5,\infty] \end{cases}$$

Fig. 2 Whitenization weight function diagram

3. three assessment index set and the relative weight vectors:
   (a) the collection of indicators:$U_{B1} = \{C_1,C_2,C_3,C_4,C_5,C_6\}$;$U_{B2} = \{C_7,C_8,C_9,C_{10},C_{11},C_{12}\}$; ... ;$U_{B14} = \{C_{65},C_{66},C_{67},C_{68}\}$
   (b) weight vector: $W_{B1} = [0.1259,0.3705,0.0771,0.1144,0.2719,0.0401]$; $W_{B2} = [0.2636,0.1164,0.0371,0.3911,0.1245,0.0673]$; ... ; $W_{B14} = [0.3814,0.1829,0.0624,0.1179]$

3.2 Evaluation Sample Matrix Is Determined According to the Rating Scale Standard

The Guilin tourism development stage for evaluation, I invited eight long been engaged in tourism management, research, familiar with the course of development of Tourism and the Tourism Development and Reform deeper theoretical attainments and practical experience of experts according to the stage of tourism development indicators evaluation criteria and Likert scale of each index assignment: tourism development stage of evaluation from low to high divided into five grades, respectively, a value of 1, 2, 3, 4, 5, between adjacent two the index level between the level of the corresponding rating 1.5,2.5,3.5,4.5 (Gong Weiling 2004).

3.3 The Evaluation Gray Determine

Determining the evaluation gray class requirements and phased evaluation criteria and indicators corresponding to this paper, the five evaluation gray class, gray class level determine u, $u = 1, 2, 3, 4, 5$, it denote a single stores dispersed phase, business diversification phase, the organizational form of large-scale stage, the cloud of wisdom tourism operator stage, the integration of innovative phase of globalization. Corresponds to the evaluation gray value vector for $\odot = (\odot_1, \odot_2, \odot_3, \odot_4, \odot_5)$, Whiten weight function fu(dik) as follows:

the first gray class: the single stores decentralized stage($u = 1$), Gray number $\odot_1 \in [0,1,2]$, Whitening weight function in mindf1.

Second gray type: Business diversification stage($u = 2$), Gray number $\odot_2 \in [0,2,4]$, Whitening weight function in mindf2,

Third gray categories: organizational form of large-scale stage($u = 3$), Gray number $\odot_3 \in [0,3,6]$, Whitening weight function in mindf3

Fourth gray type: travel wisdom as cloud computing stage($u = 4$), Gray number $\odot_4 \in [0,4,8]$, Whitening weight function in mindf4

the fifth gray class: Integration and Innovation phase of globalization($u = 5$), Gray number $\odot_5 \in [0,5,10]$, Whitening weight function in mindf5

3.4 Gray Evaluation Coefficient of Determination

Whitening weight function, according to the various stages of the expert scoring, it results into the three indicators gray evaluation coefficient. To the indicators C_1 and $C_{68,}$ for example, the development of tourism in Guilin is the u-th evaluation gray evaluation coefficient n_{Biku} the calculation of the total number of gray evaluation n_{Biku} results shown.

3.5 Gray Evaluation Weight Vector and Weight Matrix

1. calculation of the weight vector of gray evaluation

Gray evaluation coefficient based on three indicators n_{Biku} total gray evaluation n_{Biku} calculation results and formulas $r_{Bih} = n_{Biku}/n_{Bik}$ get its belonging to the u-evaluation gray evaluation weight vector (to r_{Biu}).

2. calculation of the weight matrix of the gray evaluation

According to the subject being evaluated three indicators C_i X belongs evaluation gray class gray evaluation weight vector based on the comprehensive, all three indicators C_i gray evaluation matrix R_{Bij} results are as follows:

$$R_{B11} = \begin{bmatrix} 0.0000 & 0.2249 & 0.3298 & 0.2474 & 0.1979 \\ 0.0000 & 0.2376 & 0.3244 & 0.2433 & 0.1946 \\ 0.0000 & 0.1780 & 0.3412 & 0.2671 & 0.2137 \\ 0.0000 & 0.1561 & 0.3420 & 0.2788 & 0.2230 \\ 0.0000 & 0.1684 & 0.3367 & 0.2750 & 0.2200 \\ 0.0000 & 0.1462 & 0.3375 & 0.2868 & 0.2295 \end{bmatrix}$$

$$R_{B12} = \begin{bmatrix} 0.0000 & 0.1362 & 0.3328 & 0.2950 & 0.2360 \\ 0.0000 & 0.1462 & 0.3375 & 0.2868 & 0.2295 \\ 0.0000 & 0.2029 & 0.3306 & 0.2592 & 0.2074 \\ 0.0000 & 0.1362 & 0.3328 & 0.2950 & 0.2360 \\ 0.0000 & 0.1807 & 0.3313 & 0.2711 & 0.2169 \\ 0.0000 & 0.1684 & 0.3367 & 0.2750 & 0.2200 \end{bmatrix}$$

$$\bullet\bullet\bullet$$

$$R_{B53} = \begin{bmatrix} 0.0000 & 0.1155 & 0.3233 & 0.3118 & 0.2494 \\ 0.0000 & 0.2249 & 0.3298 & 0.2474 & 0.1979 \\ 0.0000 & 0.1155 & 0.3233 & 0.3118 & 0.2494 \\ 0.0000 & 0.1561 & 0.3420 & 0.2788 & 0.2230 \end{bmatrix}$$

3.6 Index Comprehensive Evaluation

1. for comprehensive evaluation the three index set U_{Bi}

According to the obtained above three-index grey evaluation matrix R_{Bij}, three-level assessment of the relative weighting vector W_{Bij} and formulas $Z_{Bi} = W_{Bi} \cdot R_{Bi} = (z_{B1g}, z_{B2g}, z_{B3g}, \ldots, z_{Big})$, the comprehensive evaluated result of level III indicators collection for the object X is got, namely the grey evaluation of secondary indicators weight vector z_{Biu}.

2. for comprehensive evaluation the second index set U_{Ai}

According to the obtained above three indicators set U_{Bi} comprehensive evaluation (of the two indicators gray evaluation weight the vector z_{Biu}) to get the two indicators of the evaluation object X collection U_{Ai} the evaluation gray evaluation weight matrix R_{ai} results as follows:

$$R_{A1} = \begin{bmatrix} 0.0000 & 0.1996 & 0.3322 & 0.2601 & 0.2080 \\ 0.0000 & 0.1475 & 0.3333 & 0.2884 & 0.2307 \\ 0.0000 & 0.2271 & 0.3256 & 0.2485 & 0.1988 \end{bmatrix}$$

$$R_{A2} = \begin{bmatrix} 0.0000 & 0.2114 & 0.3303 & 0.2546 & 0.2037 \\ 0.0000 & 0.3039 & 0.3237 & 0.2075 & 0.1650 \\ 0.0000 & 0.2235 & 0.3304 & 0.2478 & 0.1982 \end{bmatrix}$$

$$\bullet\bullet\bullet$$

$$R_{A5} = \begin{bmatrix} 0.0000 & 0.1999 & 0.3325 & 0.2598 & 0.2078 \\ 0.0000 & 0.2367 & 0.3136 & 0.2499 & 0.1999 \\ 0.0000 & 0.1108 & 0.2441 & 0.2165 & 0.1732 \end{bmatrix}$$

Obtained according to the above two indicators gray evaluation matrix R_{Ai}, two assessment yuan relative weight vector W_{Ai} and formula $Z_{Ai} = W_{Ai} \cdot R_{Ai} = (z_{A1g}, z_{A2g}, z_{A3g}, \ldots, z_{Aig})$, to get the two indicators of the subject being evaluated X the collection U_{Ai} evaluation results, that is an indicator of the gray evaluation weight vector z_{Aiu}.

3. comprehensive evaluation of a set of indicators U_A

According to the above-obtained two set of indicators U_{Ai} results of the evaluation (i.e., an indicator of the gray evaluation weight vector z_{Aiu}) X is a subject being evaluated index set U_A gray evaluation weight matrix R_A for each evaluation gray class results as follows:

$$R_A = \begin{bmatrix} 0.0000 & 0.1693 & 0.3322 & 0.2769 & 0.2215 \\ 0.0000 & 0.2375 & 0.3285 & 0.2413 & 0.1928 \\ 0.0000 & 0.2058 & 0.3269 & 0.2596 & 0.2077 \\ 0.0000 & 0.2498 & 0.3186 & 0.2398 & 0.1918 \\ 0.0000 & 0.2003 & 0.2976 & 0.2423 & 0.1938 \end{bmatrix}$$

Level indicators obtained above gray evaluation matrix first-level R_A, the yuan relative weight vector W_A and formulas $Z_A = W_A \cdot R_A = (z_{A1}, z_{A2}, z_{A3}, \ldots, z_{Ag})$, an index subject being evaluated X collection U_A comprehensive evaluation of the results of the index comprehensive evaluation weight vector z_{Au}.

3.7 Calculate the Value of Comprehensive Evaluation

According to the evaluation results obtained above, a set of indicators U_A (indicators evaluation weight vector z_{Au}) the assessment object X comprehensive set of indicators for the evaluation gray evaluation weight matrix Z_A results are as follows:

$$Z_A = \left[0.0000\ 0.2315\ 0.3213\ 0.2456\ 0.1964\right]$$

According to the above-obtained composite indicator gray evaluation matrix Z_A evaluation gray class (five stages) the value of the vector $H = (1,2,3,4,5)^T$ and formula $Z = Z_A \cdot H^T = (z_{A1}, z_{A2}, z_{A3}, \ldots, z_{Ag}) \cdot (h_1, h_2, h_3, \ldots, h_g)^T$, to obtain the Guilin current stage of development of the evaluation value Z:

$$Z = Z_A \bullet H^T = \left[0.0000\ 0.2315\ 0.3213\ 0.2456\ 0.1964\right] \bullet \begin{bmatrix} 1 \\ 2 \\ 3 \\ 4 \\ 5 \end{bmatrix} = 3.3913$$

Based on the above evaluation methods, evaluation experts play each indicator. The overall ratings of tourism develop stage value $Z_1 = 2.1900$; evaluation experts to each target hit 2 points, the tourism development stage rating value and was $Z_2 = 3.1165$; $Z_3 = 3.5088$, $Z_4 = 4.0540$, $Z_5 = 5.6843$. As usual gray comprehensive evaluation results will not be any full stage, the results of the evaluation must be between a value between the two phases. We consider taking the median as a cut-off point between the two stages, so we get $Z_{1.5} = 2.6533$, $Z_{2.5} = 3.3127$, $Z_{3.5} = 3.7814$, $Z_{4.5} = 4.8692$, the five stages of the tourist development stage indicator-based evaluation criteria evaluation system correspond to the range as follows: (1) $Z \in (2.1900, 2.6533]$, phase 1, single stores dispersed phase; (2) $Z \in (2.6533, 3.3127]$ phase 2 diversified stage of a business combination; (3) $Z \in (3.3127, 3.7814]$, phase 3, the organizational form of large-scale stage; (4) $Z \in (3.7814, 4.8692]$, phase 4, cloud of wisdom tourism operators stage; (5) $Z \in (4.8692, 5.6843]$, phase 5, the integration of the innovation phase of globalization.

4 Guilin Tourism Gap Analysis

4.1 Stage of Development Gap Analysis

According to the current stage of development maturity stage of tourism development maturity 5 phasing standard and Guilin tourism rate value $Z = 3.3913$. We can see that the Guilin tourism is still in the middle level of the third stage of the

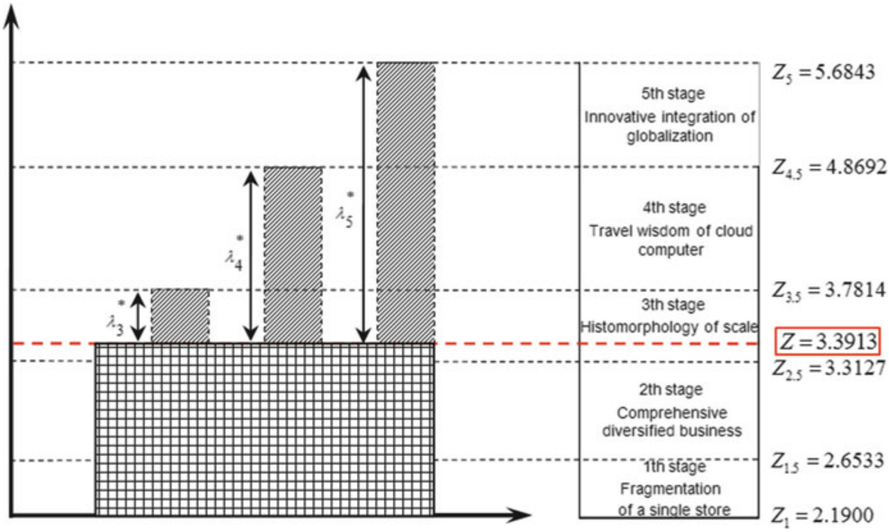


Fig. 3 Guilin tourism development maturity gap identification

Tour stage development maturity, through the next period of development time can basically achieve the large-scale requirements of the organizational form, but as cloud computing requires of tourism and wisdom, there is still a gap $\lambda_4{}^*$ integration and Innovation globalization requires greater gap $\lambda_5{}^*$, as shown in Fig. 3.

Guilin tourism development mainly bid farewell to the diversified development of the situation with a single store in the past, which are now in the business diversified organizational form of large-scale overlap Jiecha of stages, and the latter showed a good momentum of development. And strong market, demand in the near future, will become the Guilin tourism development mainstream, and it will also be a transitional platform of Guilin tourism towards the network technologies of information technology. Based on the current level of development of tourism in Guilin tourism stage of development maturity corresponding to the third, fourth, five-stage optimal value gap analysis to find weaknesses and constraint of development indicators for continuous improvement, which is developed along the travel phase the degree of development path continues to a higher stage of progression.

4.2 The Competitive Factors Gap Analysis

Figure 3 can be seen that the Guilin tourism stage has developed the critical period by the organizational form of large-scale tourism to the wisdom of the cloud operator transformation and upgrading. As the final indicator of evaluation results is determined jointly by the tourist population economy, tourism facilities, tourism industry competitiveness, tourism investment in science and technology. Tourism ecological environment have five subsystems, each subsystem is also designed several sub-factors, radar chart analysis, which is able to find the imbalance in the development of structure that is conducive to the weak indicators of restricting the development of tourism in Guilin. Thus these constraints improve the analysis and the development of effective measures to help enhance the Guilin tourism industry stage of development maturity. Indicators Grey Comprehensive Evaluation Method Guilin tourism evaluation system, two indicators rating value: $Z_{A1} = 3.5503$, $Z_{A2} = 3.3897, \ldots$, $Z_{A5} = 3.2316$; $Z_{B11} = 3.4762$, $Z_{B12} = 3.6020$, $\ldots$, $Z_{B53} = 2.6859$.

The above result was drawn to a radar chart, shown in Fig. 3, dashed poly line for of Tourism. This stage has the level evaluation index value and the secondary evaluation index value. As it can be seen in Fig. 3, currently affecting the development of tourism in Guilin level indicators A_5 tourism ecological and environmental protection, the two indicators B_{22} tourism construction investment, the three indicators of the B_{53} travel to pollutants, according to in the third stage of the stage of tourism development maturity below the lower limit, constraining the development of tourism in Guilin key the weak indicators; tourism practitioners level indicators A_2 tourism construction investment, A_4 tourism investment in science and technology and two indicators of B_{13}, B_{23} tourism promotion investment, indicators B_{41} scientific research personnel, B_{42} indicators of research funding, B_{43} research overall indicators, B_{52} travel eight indicators of the ecological environment rating value did not exceed 3.45, restricting the development of tourism in Guilin secondary weak key indicators, especially tourism investment in science and technology and their respective personnel, funding integrated indicators of overall deficiencies, which shall be paid special attention; each of the other indicators are relatively good. But from the tourist stage of development of the maturity of the fourth, fifth stage there is still a certain distance, the need to continue to maintain its advantage, while tapping the potential synergies, Guilin tourism development maturity smooth transition to the fourth stage, and strive to achieve the fifth stage as soon as possible to continue to play a key role (Liao Yanli and Tang Feihong 2011).

5 Conclusion

Based on the above evaluation results, this paper considers the Guilin National Tourism comprehensive reform pilot area construction, which should take the following measures:

The construction of the pilot area as an opportunity focus on science and technology guidance and support role in the development of tourism and related industries, through travel technology developers, the travel technology policy support, tourism, science and technology intermediary services, tourism industry and other means to achieve the transformation and upgrading of the tourism industry further maintain the good momentum of the development of tourism in Guilin, Guilin tourism development maturity is possible to a higher stage of transformation.

It strengthen tourism management departments, research institutes, colleges and universities in the introduction of scientific and technological personnel and R&D funding efforts to promote scientific research achievements into practical productive forces; further strengthen the scientific and technological integration in the tourism industry, tourism development, the construction of tourist facilities, the tourism ecological and environmental protection and tourism industry to enhance the competitiveness and other aspects of support role.

Establish and improve the Guilin tourism and the World Tourism Organization, tourism counterparts outside the region, major colleges and universities in the region exchanges and cooperation mechanisms, in particular, to strengthen the organic integration of the “official, production, learning and research”, to encourage scientific and technological innovation, industrial innovation, product innovation, service innovation, and actively promote scientific research achievements into the development of the tourism industry and the practical application.

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A Forecasting Model for the Detection Demand of Automobiles

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Abstract The paper proposes a GM (1, N) model for urban automobile detection demand forecast, which lays the foundation for the planning of detection site capability as well as the site network. The paper considers the automobile detection regulation, and takes the vehicle ownership in each class basing on the detection rule as the input variables. The grey incidence analysis is applied to determine the variables to employ, and then build up the GM (1, N) model for vehicle detection demand forecast. The efficiency of model is validated with the data of the City of Tianjin.

Keywords Automobile detection • Demand forecast • Multinomial grey model

1 Introduction

The soaring of automobile ownership in large urban cities brings special burden to the public transit safety, energy consumption and the environment protection. The legislation-enforced automobile detections, which incorporate the inspection of the vehicle safety performance, the composite properties and the environmental protection performances, play a vital role in maintaining the general performance of the running vehicles (Loeb 1990, 1985; Peltzman 1975). Therefore, an accurate forecast of the vehicle detection demand lays the foundation of a well-designed detection site network as well as the capacity allocations. However, the forecast of

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auto-detection demand does not equal that of the vehicle population (Wang 2005; Abu-Eisheh and Mannering 2002; Dagsvik and Liu 2009), since the forecasts of the two objectives differ in contributing factors. The legislation-enforced detection of automobile differs in detection cycles. The detection cycles of automobile vary for vehicles of different types (heavy, large, small, mini et al.) and commerciality (commercial or non-commercial), and adjust as the age of vehicle increases. Take the regulation for the automobile safety detection for example (Regulation on the implementation of the Road Traffic Safety Law of the People's Republic of China. State Council of the People's Republic of China 2004):

For the detection of the automobiles, ever since the day of registration, (1) for the commercial passenger vehicles (including bus, taxi and car-for-rental et al.) once a year in the first 5 years, and twice a year after that; (2) for motor truck and large non-commercial passenger buses, once a year in the first 10 years, and twice a year after that; (3) for small and mini non-commercial passenger vehicles, once every 2 years in the first 6 years, twice a year from the seventh year to the fifteenth, and twice a year after 15 years; (4) for the motorcycles, once every 2 years in the first 4 years, and once a year after that; (5) for the tractors and the else once a year.

Thus, the vehicle detection demand largely depends on the type-based vehicle ownership, vehicle age distribution as well as type-based detection rule and so on. This makes it necessary to classify the vehicles and consider independently the impact pattern of each classification on the total detection demand. An intuitive approach is to take the ownership of vehicles in each class as an independent variable, and build up the regression model to reach the goal of detection demand forecast. The multinomial based forecasting models include the two-BP neural network model (Zhou and Yang 2001) which considered the socio-economic indexes; the econometric forecasting model (Gong and Jin 2005) and the scenario analyses based multivariate forecasting model (Ma and Gao 2007), and so on. Considering the composition of the end-of-life vehicles, Liu et al. (2011) estimated the regional distribution of the amount and the composition of the end-of-life vehicles.

However, with the fact that the legislation system of the urban automobile detection was set up some a little late and still in improvement, it's hard to obtain the complete statistic data of the classified vehicles. What's more, the available statistic year is quite small. Apart, the urban automobile detection demand exhibits large volatility and certain greyness and uncertainty, as a result of the mobility of the automobiles and the flexibility in detection execution times. The traditional statistic based prediction approaches, like the single-factor regression based on the overall vehicle holdings, which in most neglect the inspection rules and the impact of vehicle classifications, thus may not work well. Hence, the grey system theory (Deng 1982, 1989) is considered in this paper. The grey system theory suits well for the analysis of data in small-sample and of large fluctuations; it may keep the consistency between the quantitative results and the qualitative analyses and enjoys wide applications (Tien and Chen 2002; Meng 1993; Erdal et al. 2010). This paper considers the legislation requirements in the automobile detection cycles, takes the classified auto holdings based on the vehicle inspection regulation, and the due-to-inspect vehicles[1] as the input variables, and builds up a GM (1, N) forecasting model. Grey incidence analysis and the qualitative analysis are employed to determine the effective input variables. Then the classified automobile holdings as well as the detection statistics in the City of Tianjin are examined, to validate the effectiveness of the proposed prediction model.

The rest of the paper is proceeds as follows, the GM (1, N) forecasting model is built up in Sect. 2, which contains the variable selection and the modeling. Three demand forecasting models are constructed in Sect. 3, and are examined with the data from the City of Tianjin during the year 2003–2012 (Sect. 4). Section 5 concludes the paper with brief comments.

2 The GM (1, N) Model

2.1 *Determination of the Effective Factors in the GM (1, N) Model*

In the GM (1, N) model, the classified automobile ownerships based on the detection regulations and the due-to-inspect vehicles are taken as the independent variables, while the annual recorded vehicle detection data is regarded as the dependent variable. However, some independent variables contribute little to the overall detection demand in fact, due to some practical reasons, thus need to eliminate. The grey incidence analysis is applied to specify the effective factors that correlate closely to the dependent variables.

Grey incidence analysis is a method to determine the correlation between variables, based on the variable geometrical distances, either in the micro or macro level (Liu and Xie 2008). In the formulation of the model, the independent variables are ranked according to their incidence degrees to the dependent variable. At the same time, the regression coefficients of each independent variable are determined (as will be discussed in the following), and then determine if the polarity of variable coordination is consistent with the qualitative analysis. Then the reverse elimination approach (Chen et al. 2012) is adopted to delete the non-correlate factors according to the incidence ranking, until all the reserved variables are consistent in polarities with the qualitative analyses.

2.2 *The GM (1, N) Model*

GM (1, N) model is the first-order multi-dimension grey model consists of N variables, among which one is the dependent variable (i.e., the vehicle detection

[1]The number of vehicles which should have been inspected according to the regulation of the inspection cycle.

demand $y(j)$ $(j = 1, 2, \ldots, M)$ in this paper), the other $N - 1$ are the independent variables $x_i(j)$ $(i = 1, 2, \ldots, N-1; j = 1, 2, \ldots, M)$, i.e., the classified vehicle ownership statistics, the corresponding variable vectors are X and Y.

Assume the original data columns are:

$$X_i^{(0)} = \left(x_i^{(0)}(1), x_i^{(0)}(2), \cdots, x_i^{(0)}(M)\right) \quad (i = 1, 2, \ldots, N-1) \tag{1}$$

and

$$Y = (y(1), y(2), \cdots, y(M)) \tag{2}$$

Do the first order accumulating generator operator upon the original data, we have the 1-AGO data columns as $X_i^{(1)}$ and $Y^{(1)}$,

$$\begin{gathered} x_{\mathrm{i}}^{(1)}(k) = \sum_{j=1}^{k} x_{\mathrm{i}}^{(0)}(k); \\ y^{(1)}(k) = \sum_{j=1}^{k} y^{(0)}(k). \quad (i = 1, 2, \cdots, \mathrm{n}; k = 1, 2, \cdots, M). \end{gathered} \tag{3}$$

Let $Z^{(1)}$ be the mean generation of consecutive neighbors sequence of the 1-AGO detection demand $Y^{(1)}$, which is computed as,

$$\mathrm{z}^{(1)}(k) = {}^{1}\!/_{2}\left(\mathrm{y}^{(1)}(k) + \mathrm{y}^{(1)}(k-1)\right). \quad (k = 2, 3, \cdots, M). \tag{4}$$

Based on the differential equation $\frac{dy}{dt} + ay = \sum_{i=1}^{n} b_i x_i$, we have the grey-difference GM (1, N) model for the detection demand forecast as

$$y(k) + az^{(1)}(k) = \sum_{i=1}^{n} b_i x_i^{(1)}(k), \tag{5}$$

the corresponding whitening differential equation is

$$\frac{dy^{(1)}(k)}{dt} + ay^{(1)}(k) = \sum_{i=1}^{n} b_i x_i^{(1)}(k), \tag{6}$$

in which $-a$ is the systematic development coefficient, $b_i x_i^{(1)}(k)$ is the system drive factor (b_i is the correlation coefficient). Let $\widehat{\pi} = [a, b_1, b_2, \cdots, b_n]$ be the associated parameter vector, whose least square estimation satisfies

$$\widehat{\pi} = \left(\mathrm{B}^{\mathrm{T}}\mathrm{B}\right)^{-1}\mathrm{B}^{\mathrm{T}}\mathrm{Y},$$

$$\mathrm{B} = \begin{bmatrix} -z^{(1)}(2) & x_1^{(1)}(2) & \dots & x_n^{(1)}(2) \\ -z^{(1)}(3) & x_1^{(1)}(3) & \dots & x_n^{(1)}(3) \\ \dots & \dots & \dots & \dots \\ -z^{(1)}(M) & x_1^{(1)}(M) & \dots & x_n^{(1)}(M) \end{bmatrix}, \tag{7}$$

Substitute the parameters in Eq. (6) with the estimated parameters in $\widehat{\pi}$, we obtain the discrete response function of the GM (1, N) as

$$\begin{aligned}\widehat{y}(k) = {} & \left[y(1) - \frac{b_1}{a}x_1^{(1)}(k) - \frac{b_2}{a}x_2^{(1)}(k) - \cdots - \frac{b_n}{a}x_n^{(1)}(k)\right]\mathrm{e}^{-a(k-1)} \\ & + \frac{b_1}{a}x_1^{(1)}(k) + \frac{b_2}{a}x_2^{(1)}(k) + \cdots + \frac{b_n}{a}x_n^{(1)}(k), \quad k = 1, 2, \ldots, M. \end{aligned} \tag{8}$$

Do the inverse accumulating generator operator, we get the r-IAGO equation of the GM (1, N) demand forecasting model as

$$\begin{aligned}\widehat{y}(k) &= \widehat{y}^{(1)}(k) - \widehat{y}^{(1)}(k-1) \\ &= -az^{(1)}(k) + \sum_{i=1}^{n} b_i x_i^{(1)}(k), \quad k = 1, 2, \ldots, M \end{aligned} \tag{9}$$

in which we assume that $\widehat{y}(1) = y(1)$.

3 Numerical Examples

In this paper, we take the City of Tianjin as an example to examine the model. In the GM (1, N) demand forecasting model, the classified automobile ownership and the annual due-to-inspect vehicles are taken as the input variables, the annual vehicle detection quantity is taken as the output variable (the data from the year 2003 to 2012 are listed in Table 1). At the same time, we also construct the single-factor regression model which considers the annual total vehicle ownership and the multinomial linear regression model as control set. The results are compared and analyzed.

3.1 The GM (1, N) Forecasting Model

Based on the analysis of degree of grey incidence in Sect. 2.1, we have the degree of grey incidences between the six input variables x_i $(i = 1, 2, \ldots, 6)$ and the annual

Table 1 The classified vehicle ownership and the annual detection quantity in the city of Tianjin from 2003–2012[a]

Year	Commercial passenger autos	Motor-truck + towed vehicle + large non-commercial passenger buses	Non-commercial cars	Motorcycle + three wheeler	Tractor and others	Due-to-inspect number	Annual detection quantity
	x_1	x_2	x_3	x_4	x_5	x_6	y
2012							1,028,470
2011	57,824	262,120	1,590,288	150,088	2,306	380,361	737,111
2010	55,871	239,013	1,288,384	172,730	35,852	373,185	630,870
2009	54,301	208,291	1,038,106	223,769	33,722	338,245	396,568
2008	48,384	188,336	841,223	263,878	39,177	311,236	369,227
2007	47,286	180,794	699,349	*286,221*	*36,915*	301,658	284,917
2006	46,272	167,372	575,093	*373,048*	*34,210*	274,569	352,845
2005	45,140	157,927	473,145	*386,717*	*65,906*	189,865	233,507
2004	43,973	157,279	382,968	*366,361*	*13,826*	223,650	323,469
2003	43,951	183,173	307,363	*416,081*	*54,914*	180,368	

[a]Note that, the prediction of the vehicle detection demand in the next year is computed based on the annual records in the current year. Thus the annual detection quantity in 2003 and the classified records in 2012 are not considered

vehicle detection number y as $C = [0.7705\ 0.7979\ 0.8993\ 0.6369\ 0.6658\ 0.8106]$ the corresponding ranking is $C_3 > C_6 > C_2 > C_1 > C_5 > C_4$, the respective coefficient vector for the grey forecast model is $A = [0.9931\ \ 43.3960 - 1.5488\ \ 0.5375 - 1.2409 - 4.4254 - 4.2257]$. It's observed that, the coefficient for the variable of the minimal degree of grey incidence, i.e., x_4 (Motorcycle + Three-wheeler) is negative, which is inconsistent with qualitative analysis (which we believe should contribute to the increase of total detection number), thus should be eliminated.

Similarly, we eliminate the variable x_5 (Tractor and others), for which the corresponding degree of grey incidence is $C = [0.7705\ 0.7979\ 0.8993\ 0.6658\ 0.8106]$, the respective regression coefficient vector is $A = [2.0666\ 24.0080\ 0.6804\ 1.5523 - 3.9633 - 4.9587]$. So, the variables reserved in the final model are (x_1, x_2, x_3, x_6), the respective degree of grey incidence and the regression coefficients are $C = [0.6202\ \ 0.6571\ \ 0.8135\ \ 0.6821]$ and $A = [1.7177\ \ 2.8553\ \ 4.2143\ \ 1.2715 - 3.9401]$ respectively.

This result is consistent with the actual observations, along with the increase in overall automobile ownership, the number of motorcycles + three-wheelers, tractors and other special vehicles decreases at the same time. What's more, the coverage of these two vehicle types adjusted as a result of the detection regulation changes, which adds to the fluctuation in statistic records (see the italic data item in Table 1 in column x_4 and x_5). Apart, the detections of these special automobiles in practice are conducted by other special-vehicle inspection organization, which is not covered in the above record, and thus contribute less to the annual detection demand. The grey incidence analysis can correctly recognize the effective determinants, further validates the effectiveness of the grey model.

Based on the above grey incidence analysis, we construct the GM (1, 5) forecasting model including x_1, x_2, x_3 and x_6 as input variables. The corresponding whitenization equation is

$$\begin{aligned}\hat{y}(k) = &\left[323{,}469 - \frac{2.8553}{1.7177}x_1^{(1)}(k) - \frac{4.2143}{1.7177}x_2^{(1)}(k) - \frac{1.2715}{1.7177}x_3^{(1)}(k)\right.\\ &\left.+\frac{3.9401}{1.7177}x_6^{(1)}(k)\right]\mathrm{e}^{-1.7177(k-1)} + \frac{2.8553}{1.7177}x_1^{(1)}(k) + \frac{4.2143}{1.7177}x_2^{(1)}(k)\\ &+ \frac{1.2715}{1.7177}x_3^{(1)}(k) - \frac{3.9401}{1.7177}x_6^{(1)}(k), \end{aligned} \tag{10}$$

the respective grey forecasting model is

$$\begin{aligned}\hat{y}(k) &= \hat{y}^{(1)}(k) - \hat{y}^{(1)}(k-1)\\ &= -1.7177z^{(1)}(k) + 2.8553x_1^{(1)}(k) + 4.2143x_2^{(1)}(k)\\ &\quad + 1.2715x_3^{(1)}(k) - 3.9401x_6^{(1)}(k)\end{aligned} \tag{11}$$

3.2 The GM (1, 1) Forecasting Model

Based on the overall annual automobile ownerships, the paper builds up the single-factor regression model forecasting model without considering the classified vehicle ownerships,

$$\widehat{y}(k) = -459,690 + 0.5696y^{(0)}(k) \tag{12}$$

3.3 The Multivariable Linear Regression Model

Apart from the two models mentioned above, we also build a multivariable linear regression model. It takes the five categories of vehicle ownerships and also the due-to-inspect vehicle quantity as the input variables, and takes the annual vehicle detection number as dependent variable. The statistical analysis software SPSS is utilized to build up the model, the variables reserved in the model is selected by applying the *step-in* method. The multivariable linear regression model is

$$\widehat{y}(k) = -866,902 + 6.9707x_2, \tag{13}$$

with only one variable reserved (x_2, the motor-truck + towed vehicle + Large non-commercial passenger buses).

4 Results and Analysis

The results of the three models are presented in Table 2. In each model, we collect the forecast of annual detection number $\widehat{y}$, the residual error $(y - \widehat{y})$ and the relative errors (absolute value $|y - \widehat{y}|/y$).

It shows that, without considering the impact of the classified automobile ownership on the annual detection demand, the single-factor based GM (1, 1) forecasting model generates the highest residual errors as well as the relative errors (absolute value) with the mean value of 64,983 and 16.34 % respectively. While on the other side, the multinomial models that take into consideration of the classified vehicle ownerships, which based on the detection legislation, produce much lower residual errors and relative errors generally. In detail, the GM (1, N) model obtain generally higher accuracy than the multinomial linear regression model does, the average residual error and relative absolute error is (10,422, 0.0807) to (10,810, 0.1025). It's observed from the results that, (1) the negligence of the impact of automobile detection regulations on the detection demand will result in higher

Table 2 The results of each model

Year	Annual detection number (y)	GM (1,N) Prediction ($\hat{y}$)	GM (1,N) Residual error ($y-\hat{y}$)	GM (1,N) Relative error ($\lvert y-\hat{y}\rvert/y$)	GM (1,1) Prediction ($\hat{y}$)	GM (1,1) Residual error ($y-\hat{y}$)	GM (1,1) Relative error ($\lvert y-\hat{y}\rvert/y$)	regression model Prediction ($\hat{y}$)	regression model Residual error ($y-\hat{y}$)	regression model Relative error ($\lvert y-\hat{y}\rvert/y$)
2012	1,028,470	1,043,950	15,480	0.0150	931,882	96,587	0.2986	960,269	68,200	0.0663
2011	737,111	777,034	39,923	0.0541	773,554	−36,443	0.1561	799,196	−62,085	0.0842
2010	630,870	594,111	−36,758	0.0582	620,553	10,316	0.0292	585,041	45,828	0.0726
2009	396,568	452,270	55,702	0.1404	504,237	−107,669	0.3779	445,939	−49,371	0.1245
2008	369,227	351,832	−17,394	0.0471	424,484	−55,257	0.1497	393,366	−24,139	0.0654
2007	284,917	298,186	13,269	0.0465	377,969	−93,052	0.2346	299,805	−14,888	0.0523
2006	352,845	400,749	47,904	0.1357	291,464	61,380	0.0973	233,966	118,878	0.3369
2005	233,507	198,760	−34,746	0.1488	217,047	16,459	0.0223	229,449	4,057	0.0174
Mean	–	–	10,422	0.0807	–	64,983	0.1634	–	10,810	0.1025

estimation errors, thus it is necessary to allow for the impact of the detection legislations and classify the automobiles accordingly; (2) the GM (1, N) model perform better than the linear regression model does in handling data with large variability.

5 Conclusion

This paper builds up a GM (1, N) forecasting model for the detection demand of urban automobile, in which we consider the effect of legislation regulation on the vehicle detection cycles, and classified the vehicle ownerships accordingly. Then the classified vehicle ownerships are taken as multiple independent variables. Since the classified vehicle ownership exhibits large variability and degree of greyness as a result of detection legislation improvement, the GM (1, N) model is adopted. Then the statistic data in the City of Tianjin from the year 2003–2012 is taken as an example to examine the proposed model. Two other models are constructed including the single –factor regression model which allows for the overall annual vehicle ownership, and the multinomial linear regression model. The GM (1, N) forecasting model attain lower forecast errors than the other two models, which validates the effectiveness of the GM (1, N) model in urban automobile detection demand forecast, and the necessity to consider the impact of automobile detection legislations on the annual detection demand.

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Application of Fuzzy Matter Element Model in Evaluation of Traffic Noise in Residential Area Using Euclid Approach Degree

Xue Xiao, Wen-zhou Jin, Lu-ou Shen, and Jian Wei

Abstract Based on the fuzzy matter element analysis and the combination of the concept of Euclid approach degree, this paper suggests a new model for evaluating traffic noise. The model takes into account both the objective measurements like the traffic noise and the acoustic environment, and the subjective reaction caused by noise. Case studies of evaluating impact of traffic noise on residents confirmed the feasibility of the model.

Keywords Euclid approach degree • Fuzzy matter element • Traffic noise

1 Introduction

Traffic noise is an important factor influencing the residential acoustic environment. The impact of traffic noise for residents is not only associated with the road traffic situation near the residential community but also associated with residential community planning (Yao 2006; Yong-sheng Jiang and Qiu-ping Wang 2009; Plakhotnik et al. 2005). In addition, the discomfort caused by traffic noise varies due to personal physical and psychological characteristics (Peng Zhang et al. 2011; Xi Cheng et al. 2009; Fei Shao et al. 2009). So the evaluation of traffic noise in residential community should consider three influencing factors, including objective actual measurement of the traffic noise, the acoustic environment and the subjective reaction caused by noise.

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2 Evaluating Model of Fuzzy Matter Element

2.1 Fuzzy Matter Element Model

Fuzzy matter-element uses “matter, character, fuzzy value” as the primary elements to describe a matter. Suppose that N is a matter, C is the character of N, and v is fuzzy value of C, then there exists an ordered fuzzy matter element: $R = \{N, C, V\}$. If the value of the matter element has fuzziness, the matter-element is called fuzzy matter element (Liu et al. 2007).

If N has n characters $C_1, C_2, \ldots, C_n$ and their corresponding values $v_1, v_2, \ldots, v_n$, R is called an n-dimensional fuzzy matter-element. If n-dimensional fuzzy matter-elements of m matters combine, they form $R_{m\times n}$, which is defined as:

$$R_{m\times n} = \begin{bmatrix} & M_1 & M_2 & \cdots & M_m \\ C_1 & v_{11} & v_{21} & \cdots & v_{n1} \\ C_2 & v_{12} & v_{22} & \cdots & v_{n2} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ C_n & v_{1n} & v_{2n} & \cdots & v_{mn} \end{bmatrix}. \tag{1}$$

Where $R_{m\times n}$ is a compound fuzzy matter-element of m things with n fuzzy characters, M_i $(i = 1,2,\ldots,m)$ is the ith thing, C_j $(j = 1,2,\ldots,n)$ is the jth character, v_{ij} is fuzzy value of the ith thing against the jth character (Yong-xia Wei et al. 2010; Xiao-ping Wu and Xiu-fang Chen 2003).

2.2 Preference Subordinate Degree Principle

The subjection degree of the fuzzy value which is corresponding to every evaluation index with the fuzzy value of single evaluation index in the standard sample is called preference subordinate degree. The principle established according to the degree and is called the preference subordinate degree principle. Generally, there are two types of indexes.

For the index which is the bigger the better:

$$u_{ij} = v_{ij} / \max v_{ij} \tag{2}$$

For the index which is the smaller the better:

$$u_{ij} = \min v_{ij} / v_{ij} \tag{3}$$

Where: $\max v_{ij}$ and $\min v_{ij}$ are the maximum value and the minimum value of each evaluation index in each scheme respectively, according to this, the preference subordinate degree fuzzy matter-element can be established as follow (Jun-long Zhou 2010; Xiao-lu Yuan et al. 2010):

$$\overline{R_{m\times n}} = \begin{bmatrix} & M_1 & M_2 & \cdots & M_m \\ C_1 & u_{11} & u_{21} & \cdots & u_{n1} \\ C_2 & u_{12} & u_{22} & \cdots & u_{n2} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ C_n & u_{1n} & u_{2n} & \cdots & u_{mn} \end{bmatrix} \tag{4}$$

2.3 Standard Fuzzy Matter-Element and Difference Square Fuzzy Matter Element

Standard fuzzy matter-element R_{0n} is determined according to the maximum value or the minimum value of the preference subordinate degree of every evaluation index in $\overline{R_{m\times n}}$. If we use $\Delta_{ij} = (u_{0j} - u_{ij})^2$, $(i = 1, 2, \ldots, m; j = 1, 2, \ldots, n)$ to express the difference square of every corresponding element in R_{0n} and $\overline{R_{m\times n}}$, then the composite fuzzy matter-element of difference square R_Δ can be established as follow:

$$R_\Delta = \begin{bmatrix} & M_1 & M_2 & \cdots & M_m \\ C_1 & \Delta_{11} & \Delta_{21} & \cdots & \Delta_{m1} \\ C_2 & \Delta_{21} & \Delta_{22} & \cdots & \Delta_{m2} \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ C_n & \Delta_{1n} & \Delta_{2n} & \cdots & \Delta_{mn} \end{bmatrix} \tag{5}$$

2.4 Euclid Approach Degree

Approach degree represents the degree of that the evaluated sample is close to the standard one. If the value is bigger, the two samples are closer. So the approach degree can be used to sort the schemes by the superior. The Euclid Approach degree PH_i is considered as the evaluation criterion in this paper. PH_i is calculated by $M(\cdot,+)$ method.

$$PH_i = 1 - \sqrt{\sum_{j=1}^{n} w_j \Delta_{ij}},\ i = 1, 2, \ldots, m \tag{6}$$

Here w_j denotes the weight coefficient of the *jth* evaluation index, and PH_i is the approach degree of matter *i* and the standard matter (Yan Nie et al. 2008).

Then the compound fuzzy matter-element R_{PH} of Euclid Approach degree is constituted as follow:

$$R_{PH} = \begin{bmatrix} & M_1 & M_2 \cdots & M_m \\ PH_i & PH_1 & PH_2 \cdots & PH_m \end{bmatrix} \tag{7}$$

At last, the result of traffic noise evaluation can be sorted by R_{PH}, the bigger the R_{PH} is, the better the environment of the residential community is (Na Liu et al. 2007).

3 Application of the Evaluation Model

3.1 Selection of Samples

Considering the influence of different roads, it is better to have samples located on the different sides of the same road. Taking into account the layout of residential areas, the samples should contain different arrangement of community, including residential area parallel to the road, residential area perpendicular to the road layout, as well as hybrid arrangement.

The samples this paper chose are as follow:

Sample 1: the north residential community of South China University of Technology, of which the layout is parallel to the road, is located on the west side of the intersection between Dongwanzhuang Road and South Yangtze River Road.

Sample 2: the community of weather station in Guangzhou, of which the layout is perpendicular to the road, is located on the east side of the intersection between Dongwanzhuang Road and South Yangtze River Road.

Sample 3: the community of Huijing, of which the layout is of hybrid type, is located to the north of Huijing Road.

3.2 Establishing Evaluation Model

With reference to the existing various traffic noise evaluation indexes, combining with the availability of data, considering the objective actual measurement of the traffic noise, the acoustic environment and the subjective reaction caused by noise, the writer sets up evaluation index system as follow, respectively from three influencing factor level, including the objective actual measurement of the traffic noise (A1), the residential acoustic environment (A2) and the residents' subjective reflection (A3), a total of 12 indicators.

Table 1 Evaluation indexes of traffic noise in residential community

Influencing factor level	Evaluation Indexes	Sample 1	Sample 2	Sample 3
Objective actual measurement of the traffic noise	LA value by roadside in the daytime (dB)	81	78	73
	LA value of 30 m distance from the roadside in daytime (dB)	75	70	70
	LA value of 90 m distance from the roadside in the daytime (dB)	73	64	65
	LA value by roadside in the nighttime (dB)	72	64	62
	LA value of 30 m distance from the roadside in nighttime (dB)	68	58	55
	LA value of 90 m distance from the roadside in nighttime (dB)	62	56	51
The acoustic environment in residential community	Residential community is far away from commercial parking lot, deceleration zone and other facilities	2	9	7
	Traffic arteries throughout the community	3	8	10
	The road is flat	4	8	7
Subjective reaction caused by noise	Subjective annoyance degree	5.525	4.3875	3.6
	The degree of impact on sleep	4.5875	4.4375	4.55
	The degree of impact on communication	3.075	3	2.8

The objective actual measurement of the traffic noise is a quantitative index, measured by the LA value through field measurements. In this level, the paper chose six indexes, three of which are measured in the daytime (9:30) and others are measured in the nighttime (23:00). In the level of the residential acoustic environment, the paper chose three indexes, including whether residential community is far away from commercial parking lot, deceleration zone and other facilities, whether traffic arteries throughout the community, and whether the road is flat. In the level of the residents' subjective reflection, the paper chose three indexes, including subjective annoyance degree, the degree of impact on sleep and the degree of impact on communication. The evaluation set of indexes in these two levels is [0, 10], 0 means poor and 10 means good.

Using the above evaluation set to evaluate the traffic noise in three samples communities, the writer obtained the survey data and field measured values as shown in Table 1.

1. *Construct the composite fuzzy matter element*

Considering the objective actual measurement of the traffic noise, the acoustic environment and the subjective reaction caused by noise, the writer sets up evaluation index system as shown in Table 1.

2. *Calculate the preference subordinate degree* $\overline{R_{m\times n}}$

According to formula (2), (3) and (4), $\overline{R_{m\times n}}$ was constructed as follow:

$$\overline{R_{m\times n}} = \begin{bmatrix} 0.9012 & 0.9359 & 1 \\ 0.9333 & 1 & 1 \\ 0.8767 & 1 & 0.9846 \\ 0.8611 & 0.9688 & 1 \\ 0.8088 & 0.9483 & 1 \\ 0.8226 & 0.9107 & 1 \\ 0.2222 & 1 & 0.7778 \\ 0.3000 & 0.8000 & 1 \\ 0.5000 & 1 & 0.7778 \\ 0.6516 & 0.8205 & 1 \\ 0.9673 & 1 & 0.9753 \\ 0.9106 & 0.9333 & 1 \end{bmatrix}$$

3. *Determine the standard fuzzy matter element and difference square fuzzy matter element* R_Δ

According to formula (5), R_Δ was constructed as follow:

$$R_\Delta = \begin{bmatrix} 0.009755 & 0.004109 & 0 \\ 0.004444 & 0 & 0 \\ 0.015200 & 0 & 0.000237 \\ 0.019290 & 0.000977 & 0 \\ 0.036548 & 0.002675 & 0 \\ 0.031478 & 0.007972 & 0 \\ 0.604938 & 0 & 0.049383 \\ 0.490000 & 0.040000 & 0 \\ 0.250000 & 0 & 0.049383 \\ 0.121394 & 0.032216 & 0 \\ 0.001069 & 0 & 0.000611 \\ 0.007998 & 0.004444 & 0 \end{bmatrix}$$

3.3 Index Weight Determination

3.3.1 Calculate the Weight of Each Index

Referencing literatures at home and abroad for the weight coefficient of evaluation index and combining with expert evaluation method (Na Shao et al. 2011; Marchand and Whitehead 2002), the paper choose the W as follow:

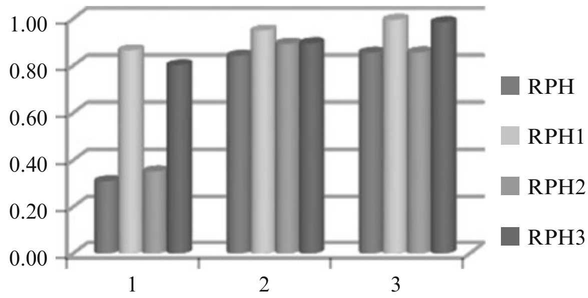

Fig. 1 The R_{PH} of three sample communities

$W = (0.1,0.05,0.05,0.1,0.05,0.05,0.1,0.1,0.15,0.075,0.1,0.075)^{\mathrm{T}}$

Similarly, calculate the weight of each index at the influencing factor level as follow:

$W(A1) = (0.25,0.125,0.125,0.25,0.125,0.125)^{\mathrm{T}}$;
$W(A2) = (0.28571,0.285714,0.428571)^{\mathrm{T}}$,
$W(A3) = (0.3,0.4,0.3)^{\mathrm{T}}$

3.3.2 Calculate Euclid Approach Degree

Calculate R_{PH} according to (7), and we can see the results from Fig. 1.

$$R_{PH} = \begin{bmatrix} \text{Sample1} & \text{Sample2} & \text{Sample3} \\ 0.309024 & 0.841795 & 0.854811 \end{bmatrix}$$
$$R_{PH1} = \begin{bmatrix} \text{Sample1} & \text{Sample2} & \text{Sample3} \\ 0.865019 & 0.948987 & 0.994561 \end{bmatrix}$$
$$R_{PH2} = \begin{bmatrix} \text{Sample1} & \text{Sample2} & \text{Sample3} \\ 0.351940 & 0.893096 & 0.855758 \end{bmatrix}$$
$$R_{PH3} = \begin{bmatrix} \text{Sample1} & \text{Sample2} & \text{Sample3} \\ 0.801896 & 0.895129 & 0.984362 \end{bmatrix}$$

3.4 Analysis of Result

Figure 1 shows the Euclid approach degree of the total level and the level of three influencing factors. According to the calculated result, the traffic noise levels of three samples from low to high are sample 1, sample 2 and sample 3. The analyses of the influencing factor level are as follow:

On the level of the objective measurement of the traffic noise, the three samples are similar, because the sample communities the paper chosen are located near traffic arteries and are greatly influenced by traffic noise. There is little difference of Euclid approach degree among samples.

On the level of the acoustic environment, sample 1 is best while sample 2 is poorest. The result presents there is a big difference of acoustic environment among samples, set of parking lot and road layout of residential community have a great influence for the residential acoustic environment.

On the level of the subjective reaction caused by noise, the results vary from the population composition in samples. Aging population accounts for large proportion in sample 1 while population composition in sample 2 and sample 3 are similar. According to the study of the influence of the layout of residential community on traffic noise, the effect to prevent traffic noise of hybrid layout community is better than that of parallel type, and parallel type is better than that of vertical type and the paper confirms this conclusion.

4 Conclusion

Through the establishment of the fuzzy matter-element model based on Euclid approach degree, this paper aims to improve the recognition of residential traffic noise for people, reveal the various problems in the course of the construction of residential areas and provide scientific basis for the perfection of the residential environment gradually.

1. In this paper, a new fuzzy matter-element model is applied to evaluate traffic noise of listed residential community. First, we calculate membership degree with membership function to constitute the fuzzy matter-element, calculate the Euclid approach degree between each sample community to be evaluated and the standard fuzzy matter-element and establish Euclid approach degree compound fuzzy matter-element finally. The results are intuitive and clear, so it is feasible to use fuzzy matter-element model to evaluate the traffic noise in residential communities.
2. Fuzzy matter-element model for evaluation of traffic noise in residential community can compare the situation of traffic noise in various residential areas at the same time, it also can compare the situation of traffic noise in the same residential area in different years. However, due to space constraints, only various residential areas at the same time can be explored here. In the case of enough data, readers can undertake follow-up studies, compare the situation of traffic noise in the same residential area in different periods.

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Evaluation Research on the Portfolio Pricing Model of Convertible Bonds

Ding-yue Kan, Chang Liu, Li Qian, Lu-yao Huang, and Hong-ye Wang

Abstract This paper first reviews the development of convertible bonds in the world, and studies relevant research domestically and internationally. Then, after the analysis of the characteristics, value composition, and detailed terms of convertible bonds, this paper has a specific analysis and quantitative research on bonds, options and value portfolio included in convertible bonds. In addition, this paper also amends the corresponding model and increases the quantitative analysis of many term values such as the dividend factors, put provisions, and call provisions included in convertible bonds.

Keywords Convertible bonds • Evaluation • Portfolio • Pricing model

1 Introduction

The convertible bond market in China started in the early 1990s. At that time, there were no formal rules and regulations of convertible bond in the country. But all types of enterprises had already begun to try to issue convertible bonds to raise funds.

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During this period, the overseas-listed Chinese companies had salutary attempts on convertible bonds. For example, Zhenhai Oil Refining and Chemical Company in London and Hong Kong, Qingling Motor in Luxembourg and Hong Kong, Huaneng Power International in New York and Luxembourg, issued convertible bonds successively, accumulating rich international experience for the convertible bond market in China. On March 25, 1997, the Securities Commission of the State Council issued the “Interim Measures for the Administration of Convertible Bonds”. At the same time, the State Council also carried out the experimental work of convertible bonds in the key state-owned unlisted companies, and the total size of the issue was four billion RMB. In this context, there were three non-listed companies issuing convertible bonds, Nanhua convertible bonds, Silk convertible bonds and Maoming Petrochemical convertible bonds. This is the first standardized action of convertible bonds in China, which not only has a lot of innovations in terms of timing, issuance provisions compared to those in the past, but also many shortcomings that cannot be overcome. In 2001, the convertible bond market had great changes. Introduced in April 2001, four supporting documents, “Implementing Method of Listed Companies Issuing Convertible Bonds”, “The Application Documents for Convertible Bonds of Listed Companies”, “Convertible Bonds Prospectus” and “Convertible Bonds Listing Announcement”, make listed companies have a legitimate market to issue convertible bonds. And China’s convertible bond market steps to the comprehensive development stage. Split share structure reform began in 2005 has new requirements for a new understanding of convertible bonds. After the share reform, the company is still happy to raise funds through the issuance of convertible bonds. The cumulative amount of convertible bonds of more than 65 listed companies preparing to issue is over 55 billion RMB. It is visible that the role of convertible bonds in financing is being strengthened. Convertible bonds have become one of the important tools of corporate financing, and it also has an important influence on the bond market (Yang Ruyan et al. 2002).

Chinese capital market always has the following problems such as overhigh proportion of equity financing, lack of investment products, difficulty of financial innovation and other issues. It is in urgent need of launching financial products such as bonds and warrants and improving the relevant market. Convertible bonds are one of the few Western innovative financial products introduced in China in recent years. Compared with the well-known stocks, corporate bonds and government bonds, it has richer content in theory, and requires higher technology in practice. In particular, the pricing and design of convertible bonds are very complex. It needs certain amendments to the classical theory model, a serious issue placed in front of the theoretical cycle.

2 Influence Factor Analysis of Convertible Bonds Pricing

2.1 Analysis of the Basic Elements of Convertible Bonds

2.1.1 Underlying Stocks

Convertible bonds have subject matter, which is usually the common stocks of listed companies and includes ordinary shares of other companies. The call option of the underlying stock is included in the price of convertible bonds, so the change of the price depends on the price movement of the underlying stock, and goes the same way with it.

2.1.2 Coupon Rate

Convertible bonds' coupon rate is generally lower than that of ordinary bonds. Convertible bonds issued in China shall not be higher than bank deposit rates over the same period. It is because the value of convertible bonds includes not only interest, but also the calls of stocks, the value of which is enough to make up for the spreads of interest rate generally, which is also the main reason for attracting investors (Wang Chengwei and Wu Chongfeng 2007).

2.1.3 Conversion Price

Conversion price is the price paid by convertible bonds for the conversion of per ordinary share. The conversion price of convertible bonds issued by listed companies in China should be prescribed in the prospectus. Price should be determined based on the average closing price of 13 corporate stocks of 30 trades before the publication of the prospectus, and float upward a certain level. The two concepts closely related to conversion price are conversion ratio and conversion premium ratio.

2.1.4 Conversion Period

The conversion period is the period of the conversion of convertible bonds into ordinary shares from the start date to the end date. The conversion period of convertible bonds can be same as the maturity of the bonds. But in most cases, the issuers all prescribe a specific period. Within the period of validity, it is allowed that the convertible bond holders convert convertible bonds into the issuer's shares at the conversion ratio or conversion price. In many cases, the company also provides that the conversion ratio during the period of validity decreases gradually or is subsidiary to call provisions. The progressive decrease of the conversion ratio is to reduce certain ordinary shares convertible in every certain number of years. That subsidiary to call provisions is that the company has the right to redeem such bonds at a certain price within a certain period. The redemption price prescribed by the company is generally slightly higher than the nominal value of the securities. When market price of the securities is higher than their redemption price, companies tend to exercise the right to redeem. At this time, if investors do not want to sell their bonds at the redemption price to the company, they can only convert them into common stocks. So redemption provisions play a role of forcing investors to implement the conversion or sell their bonds (Zhou Lin 2003). Depending on the circumstances, conversion period is usually divided into the following four kinds:

1. From 1 day after issued for a period to 1 day before the maturity date;
2. From 1 day after issued for a period to the maturity date;
3. From the issue date to 1 day before the maturity date;
4. From the issue date to the maturity date

In the first two cases, after the issuance of convertible bonds, the issuing company locks a specific period, within which the company will not accept the conversion matters, with the purpose of not wanting to prematurely convert liabilities into capital so that diluting the original shareholders' equity; in the latter two cases, the issuing company does not lock a period for convertible bonds before converting them into shares, in order to attract more investors. Normally, the conversion price is higher than the market price of the underlying stock at that time, so investors generally do not exercise the debt-for-equity swap immediately after the issuance of the convertible bonds. After 6 months from the issue date, convertible bonds in China can be converted into corporate stocks. The specific conversion period of convertible bonds should be determined by issuers in accordance with the duration of convertible bonds and the company's financial condition.

2.1.5 Call Provisions

The redemption of convertible bonds is that under certain conditions, the company buys convertible bonds which are not converted into stocks back at a pre-agreed price. Once the company issued the notice of redemption, the holders of convertible bonds must make a choice between conversion and the sale of convertible bonds. Under normal circumstances, the holders of convertible bonds will choose conversion (Hu Huaibang 2000). It is thus clear that the main function of call provisions is to force convertible bond holders to exercise their debt-for-equity swap, thus speeding up the conversion, so it is called acceleration clauses.

1. The main purpose of setting call provisions
2. The main content of call provisions

2.1.6 Put Provisions

If setting call provisions is mainly to protect the interests of the issuers, then setting put provisions is to protect the interests of bondholders. Put-back refers to the action when the company stock price is less than the conversion price continuously over a period of time, and when it reaches a certain level, holders of convertible bonds sell the bonds to the issuers at the pre-agreed price. In order to reduce the investment risk, and attract more investors, the issuing company usually sets the provisions. To some extent, it protects investors, and acts a form of investors transferring risk to the issuing company. Put-back is essentially a put option. The put provisions mainly consist of put-back date, put-back conditions, put-back price, put-back application and so on.

2.1.7 Conversion Adjustment Conditions and Protection Clause

After the issuance of convertible bonds, the asset reorganization or financing behavior will sometimes happen in the company. Sometimes these behaviors cause the conversion price higher than the current share price, making the conversion impossible. At that time it needs to adjust the conversion price in order to protect the interests of investors. Conversion adjustment conditions are sometimes referred to reset clauses. When stock performs poor, these clauses allow the issuing company to lower the conversion price to 70–80 % of the original conversion price at the appointed time. Article 27 of "Implementing Method of Listed Companies Issuing Convertible Bonds" in China provides that after the issuance of convertible bonds, when allotment, refinance, stock dividend, separation or other causes lead to changes in the shares of the issuers, it should adjust conversion price and make an announcement at the same time (He Chengfeng 2001).

2.1.8 The Duration Period of Convertible Bonds

The duration period of convertible bonds directly determines the discounted present value of the bond portion of convertible bonds. "Implementing Method of Listed Companies Issuing Convertible Bonds" in China provides that: The period of convertible bonds is 3 years at minimum, up to a maximum of 5 years, which is agreed by the issuer and lead underwriter according to the specific circumstances of the issuer.

2.1.9 The Repayment Method of Convertible Bonds

The factors such as whether the principal of convertible bonds is repayable in installments or is repayable in full at maturity and whether convertible bonds are repaid with cash or the underlying stock at maturity will affect the value of convertible bonds. Article 24 of "Implementing Method of Listed Companies Issuing Convertible Bonds" in China provides that: convertible bonds should pay the interests every 6 months or a year; within five working days after the expiration, it should pay the principal of convertible bonds which not converted into stocks and the interest of the last installment. The specific payment date and interest accrual rules should be stipulated by the issuer.

2.2 Characteristic Analysis of Convertible Bonds

2.2.1 The Property of Debt and Stock of Convertible Bonds

Convertible bonds are a hybrid financial instrument with both fixed income and equity characteristics. In the classification of financial instruments, convertible bonds are between pure equity and pure debt instruments. So it has the property of both debt and stocks. The factors having a decisive impact on the property of debt and stocks: the company scale, the company's profitability, the company's growth, the use of raising funds, the asset liability ratio of the company and the company's dividend policy (Cai Dianchun and Zhang Xin 2002).

The Company Scale

Western security analysis theory holds that the company scale can be used as a proxy variable for information asymmetry. In general, the larger the company is, the greater the degree of external information asymmetry will be and the more cautious investors are, and thus influencing the secondary market. In our country, the mechanism of the company scale playing a role is realized by the number of tradable shares, the greater the size of the tradable shares the company has, the stronger the liquidity of the company's equity will be and the property of stocks.

The Company's Profitability

This is a relatively important factor influencing the property of stocks and bonds. It is the performance support for the company's fundamentals, and is also the basic protection for the stability and rising of existing stocks in the secondary market. If the company's profitability declines, it is bound to affect the trend of the secondary market, thus affecting the company's property of stocks (Wang Xiaoxia 2005).

The Company's Growth

Mature security analysis theory usually measures the company's growth by Tobin Q, or R & D ratio. Tobin Q is the ratio of the company's market value and book value, where the book value was calculated using the replacement cost of the company first and later became the evaluation got through the future discounted cash flow. Tobin Q expects the company's growth by market evaluation. Another indicator is R & D ratio, namely the ratio of research and development expenses in the company's total sales. When calculating it, we should pay attention to using the previous year's research and development expenses of the issuance of convertible bonds to divide the issuer's sales for the present year. The higher the R & D ratio is, the greater the company's growth space will be, because technological progress can always improve production efficiency and capacity (Wang Jing 2005).

The Use of Raising Funds by the Company

Standard security analysis techniques hold that a company's market value must contain the information on investment opportunities owned by the company. The investment of convertible bonds raising funds is usually divided into capital investment, the investment of the acquisition of other companies or projects, the investment of repayment of old debts as well as a variety of uses.

The Asset Liability Ratio of the Company

When designing the provisions of convertible bonds, the liability structure of the company usually affects the orientation of the property of stocks and debt. If the company's asset-liability ratio is too high, in order to optimize the capital structure, on the one hand, the company expects stronger property of stocks when designing the issuance provisions of convertible bonds; on the other hand, the use of the company's rights after the issuance of convertible bonds, such as the right of redemption, reset clause, and the rights implied by the conversion price will tend to promote the success of conversion (Wang Li 2005).

The Company's Dividend Policy

The company's dividend policy is another important factor affecting the property of stocks and debt of convertible bonds. If the obtained dividends by investors after conversion are more than the interest when they hold, they are more enthusiastic at conversion, thus convertible bonds shows greater property of stocks. But in China, the dividend payout has become the mainstream, and the calculation of dividend yield is difficult.

2.2.2 Convertible Bonds Have a Lower Interest Rate

The interest rate of convertible bonds is lower than that of the average corporate bonds. It may not exceed the level of the bank deposit interest rate for the corresponding period, so the issuing company can reduce interest expense, and save financing costs. Investors temporarily give up part of the interest income while obtaining a conversion option (Li Li 2005).

2.2.3 The Conversion Price of Convertible Bonds Is Higher than the Average Price Level of Corporate Stock When Issued

The conversion price of convertible bonds is the price that the holders subscribe the stocks of the issuer. The price is also known as the conversion premium. The conversion price set when issuing convertible bonds is generally determined by floating upward 6–30 % based on the average stock price of the issuing company 1 month before. It is usually higher than the stock price of the issue date. The "conversion premium" is higher than 5–15 % of the stock value, reflecting that people expect the stock price to rise. For investors, they get the ideal income before the final redemption date, when the issuer's listed stock price has risen above the stipulated conversion price of convertible bonds. To enable the stock price of the issuing company to rise higher than the conversion price during the conversion period so that promote the successes of the conversion, the issuing company must create the best operation performance and accelerate the development of the company. When the shares change due to the issuance of new shares, stock dividend and other reasons, the issuing company shall timely adjust the conversion price, in order to protect the interests of investors from being affected (Fan Jing 2004).

2.2.4 The Redeemable and Put Table Nature of Convertible Bonds

The issuing company can provide in the contract the additional provisions of redeeming the bonds before the maturity date at the agreed price higher than the face value of the bonds, namely when market interest rate of the bonds declines, the issuing company redeems the old bonds at premium, and then issues new bonds at a lower interest rate. The redeemable nature of convertible bonds increases the flexibility of the issuing company's financing, helping further reduce financing costs. In the contract, it can also provide additional provision that the investors may request the issuing company to buy the bonds at a certain rate of return before the maturity date, namely when the issuing company's stock price continues lower than the conversion price in a period of time and reaches a certain amplitude, investors can return the bonds they hold at a pre-agreed price to the issuing company. The put table nature provides additional protection for the interests of investors (Wang Tiefeng 2005).

3 The Pricing Model of Convertible Bonds

3.1 The Pricing of the Bond Portion of Convertible Bonds

3.1.1 The Pricing Formula of the Bond Portion of Convertible Bonds

The pure bond price of convertible bonds can be calculated using the discounted cash flow formula. Set C_1, $C_2, \ldots, C_n$ as the cash flow of n times for a period of time, $t_1, t_2 \ldots, t_n$ as the time from cash flow occurring to the time now, the discount rate as R, then the present value C_0 of the cash flow can be determined by the following formula:

$$C_0 = C_1 e^{-Rt_1} + C_2 e^{-Rt_2} + \cdots + C_n e^{-Rt_n} = \sum_{n=1}^{N} C_n e^{-Rt_n} \tag{1}$$

Equation (1), in China's current circulation, the face values of convertible bonds are all 100 RMB, the interest is paid annually, and the principal and interest of the last year are paid at maturity. Let $r_1, r_2 \ldots, r_n$ be coupon rate of convertible bonds, $t_1, t_2 \ldots, t_n$ be the time from the time now to when convertible bonds pay the principal and interest. For interest payments, levy interest tax of 2005 with discount rate of R (continuous interest rate), then the pure bond value PV of convertible bonds can be determined as follows:

$$\begin{aligned} PV &= 100 \times (1 - 20\%)\, r_1 e^{-Rt_1} + \ldots \\ &\quad + 100 \times (1 - 20\%)\, r_N e^{-Rt_N} + 100 e^{-Rt_n} \\ &= 80 \sum_{n=1}^{N} r_n e^{-Rt_n} + 100 e^{-Rt_N} \end{aligned} \tag{2}$$

3.1.2 The Determination of the Discount Rate

There are many methods to determine the discount rate:

1. Directly use the bonds' yield to maturity or bank fixed deposit interest rate of the similar maturity as the discount rate;
2. On the basis of the bonds' yield to maturity of the similar maturity, add a certain level of credit risk premium;
3. Based on the average yield to maturity of corporate bonds of the similar maturity listed on the Shanghai and Shenzhen Stock Exchange, make the appropriate floating. In China's current circulation, the face values of the ordinary corporate bonds are all 100 RMB. Set the current price of the ordinary corporate bonds as P_0, $r_1, r_2 \ldots, r_n$ as the coupon rate of ordinary corporate bonds, $t_1, t_2 \ldots, t_n$ as the

time from the time now to when ordinary corporate bonds pay the principal and interest. Levy 20 % interest tax on the interest paid, then the yield, namely the discount rate (continuous interest rate), of ordinary corporate bonds is determined by Eq. (2).

This paper adopts the first method, and selects the 5-year bank deposit rate of 3.6 % of similar maturity for the discount rate.

3.1.3 The Pricing Formula of the Option Portion of Convertible Bonds

The assumptions of B-S option pricing model:

- The stock price follows the lognormal distribution
- There are no transaction costs and tax, options and stocks can be split unlimited
- At short options or stock, there is no market imperfection
- Risk-free interest rate r is constant and the same for any maturity date
- There are no dividend payments in the period of validity of the derivative securities
- Securities transactions are continuous

In the above premise, the valuation formula of European call option is:

$$C_1 = SN(d_1) - Xe^{-r(T-t)}N(d_2) \tag{3}$$

where:

$$d_1 = \frac{In(S/X) + \left(r + \sigma^2/2\right)(T-t)}{\sigma\sqrt{T-t}} \tag{4}$$

$$\begin{aligned} d_2 &= \frac{In(S/X) + \left(r - \sigma^2/2\right)(T-t)}{\sigma\sqrt{T-t}} \\ &= d_1 - \sigma\sqrt{T-t} \end{aligned} \tag{5}$$

C – the price of call option
T – the expiration date of the option
t – the time of observation period
S – the market price of the underlying stock
X – the agreed price specified in the option contract, namely the strike price (the conversion price)
r – risk-free rate (continuous interest rate)
σ – the volatility of the underlying stock price
$N(x)$ – the cumulative probability distribution function for standard normal variable

Table 1 The value of convertible bond calculation results

Item / Name	Bond portion of the value	Redemption option value	A put option value	Dividends paid option value
West steel bond	103.38	-2.2	1.3	10.36
Huadian debt	104.96	-3.38	2.52	46.89
The DianZhuan debt	108.15	-2.34	2.13	42.44

Given in Table 1 according to the formula to calculate the calculation results of convertible bonds.

4 Conclusion

With convertible bonds as the research object, this paper mainly uses the theory of option pricing to study convertible bond pricing, and explores and uses the modified B-S option pricing models to give a more accurate and reasonable pricing of convertible bonds. The study results show that the B-S option pricing model satisfies the condition of dividend payments. Meanwhile, after call and put provisions are brought into the pricing of convertible bonds, the calculated value of convertible bonds is closer to their real value.

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Linkage Effects of Trade Openness and Financial Openness on Technological Progress

Feng-wu Han and Ling-xue Zhu

Abstract In an open economic entity, trade openness and financial openness have both formed an interactive relationship with technology. Based on the existing research, this paper intends to establish a unified composite model and to prove in a quantitative way that in the OECD countries, technical level is mainly promoted by their investment in research and development. Although trade openness and financial openness also play positive roles in promoting technical level, their influence is relatively weak, and the promotion effect of the financial opening will delay for 1 week.

Keywords Financial openness • Technological progress • Trade openness

1 Introduction and Theoretical Analysis

Trade openness will affect technology, either for the exporters or importers. Grossman and Helpman (1991a) separately did the analysis using technology transfer brought by the international trade. They first assumes that technology transfer in international trade will bring no cost for analysis, then they divert their attention to the technology transfer which will biting cost. The conclusion they draw is that north-south trade has a profound effect on southern technology progress. But to the advances of northern technology the effect is uncertain. Ethier and Markusen (1991) believes that international trade has increased the number of intermediate products

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which include science and technology, and, as a result, the increase of the production technology level of the trading countries brings the promotion of total factor productivity. Connolly analyses the quality ladder model and points out that the entry of new invention of high quality products into the international trade system can more effectively improve the productivity level of importers. Grossman and Helpman (1991a) believe that trade openness makes importers dismantle imported products through reverse engineering method, and then the importers imitate and learn the techniques of imported products to improve their domestic technology level and, as a result, reduce the risk and uncertainty of active development. In an open economy, the productivity level of importers can improve rapidly at a low cost through more contacting with, using and dismantling products of new technology.

Study on the promoting effect of financial openness on technology mainly has the following several aspects. First, financial openness makes capital flow transnationally which can make up for the research funds demand of teams in financial opening countries (Kumar et al. 1998; UNCTAD 1999). Research and development needs a lot of funds, financial openness makes the enterprises in opening countries have more space to seek funds, which can meet the continuous need of a great sum of money.

Secondly, financial openness makes the entry of the foreign financial service mode possible, and these financial services include advanced organizational knowledge.

The capital inflows, such as venture capital funds, investment trusts funds, seed funds and angel funds which have the ability of risk identification and management, play a positive inspiring and leading role in the formations of domestic fund management and use concept. And, as a result, they have more opportunities to obtain funds to make technical innovation and thus improving the efficiency of research and development funds.

Nowadays, fierce market competition and great technological changes force all the companies to innovate constantly or look for available advanced technology. Because of financial openness, funds can search in the world for various potential of technology, talents, companies and a variety of available information and results (Pietrobelli and Samper 1997; Lucas 1990; Grossman and Helpman 1991b) to speed up their development and immediately be used of globally.

Financial openness makes transnational corporations invest transnationally, bringing the advanced technology and research and development activities in order to adapt to the local production. These technologies hire local staff and cooperate with local companies to form a complete set of production and then compete with local companies, which makes the associated economic institutions, other companies and institutions, competitive firms, the employees in the host countries absorb and digest the advanced technology (Nadiri 1991) when working, cooperating and competing with multinational corporations and thus forming the technology diffusion effect and technology transfer channel, promoting the related technology of the host countries, and this phenomenon is called technology spillovers (Kokko 1994; Sjoholm 1999).

As we can see from the above analysis, openness of trade and financial have both formed an interactive relationship with technology. But none of the existing literature has synthesized the three and this section will build a simple model to put the three together in order to quantify the relationship between them.

Assuming that the technology level of a country can be represented by the stock of intermediate products of its production M_d, and the corresponding technical level abroad can also be represented by its stock of intermediate products M_f.

At the same time, assuming that the technology level can be represented by the number of intermediate products, and it coincides with the cost of technological innovation (r^{α}) into a reverse correlation function, then its function is:

$$Tec = M_d = \zeta_d \frac{1}{r^{\alpha}}, 0 < \alpha < 1, 0 < w < 1 \tag{1}$$

$\zeta_d > 0$ is the coefficient for technology development;

Assuming that the higher the trade openness is the more foreign intermediate products we can receive. And through learning and competing with domestic enterprise products innovations are stimulated, and so $\zeta_d = \zeta_{Tec} TO^{\omega}$, here $\zeta_{Tec} > 0$, TO is the trade, thus $Tec = \zeta_{Tec} \frac{TO^{\omega}}{r^{\alpha}}$.

The foregoing analysis pointed out that trade openness is affected by the level of technology both at home and abroad. The technical differences between them form the intra-industry and inter-industry trade comparative advantages, which plays a positive role in promoting the development of international trade. At the same time, trade openness is also influenced by internal and external GDP (denoted respectively as Y_d, Y_f) and also the distance between the two sides of the impacts, so:

$$TO = \frac{\zeta_{TO} M_d^{\beta} M_f^{1-\beta}}{Dis} Y_d^{\gamma} Y_f^{1-\gamma}, 0 < \beta < 1, 0 < \gamma < 1; \tag{2}$$

ζ_{TO} is a comprehensive coefficient representing other factors that affect trade openness.

Financial openness is affected by two technological factors, on the one hand, it is affected by the decrease in operating costs of the financial system brought by technological progress and it makes the low-cost implementation of financial opening possible. Assuming that other factors are constant, then:

$$FO = \zeta_{FO} M_d^{\varphi} \tag{3}$$

$0 < \varphi < 1, \zeta_{FO}$ is a comprehensive coefficient representing other factors.

From the above three equations, we can see that technology stock can promote the openness of trade, and technology innovation is affected by the financing cost. Finance is a kind of service and with the opening up of it, all financial institutions are facing more competitors, and as market suppliers increase, their monopoly profits will be gradually reduced, then $r = \zeta_r FO^{-\lambda}$, $0 < \lambda < 1, \zeta_{FO}$ is a comprehensive coefficient representing other factors. Put r into formula (2), then $Tec = \zeta_d \frac{1}{\zeta_r^a} FO^{\lambda a}$, and as we can see, financial opening can promote technological progress.

If we plug it in the formula (3), then the relationship between trade Openness and financial openness can be described as:

$$\begin{aligned} TO &= \frac{\zeta_{TO} M_f^{1-\beta}}{Dis} Y_d^\gamma Y_f^{1-\gamma} Tec^\beta = \zeta_{Tec\to TO} Tec^\beta \\ &= \frac{\zeta_{TO}\zeta_{Tec}^\beta M_f^{1-\beta}}{Dis} Y_d^\gamma Y_f^{1-\gamma} \frac{TO^\omega}{r^{\alpha\beta}} \\ &\Rightarrow TO = \left[\frac{\zeta_{TO}\zeta_{Tec}^\beta M_f^{1-\beta}}{\zeta_r^{\alpha\beta} Dis} Y_d^\gamma Y_f^{1-\gamma} FO^{\lambda\alpha\beta} \right]^{1/(1-\omega)} = \zeta_{FO\to TO} FO^{\lambda\alpha\beta(1-\omega)} \end{aligned} \quad (4)$$

Where $\zeta_{Tec\to TO} = \frac{\zeta_{TO} M_f^{1-\beta}}{Dis} Y_d^\gamma Y_f^{1-\gamma}$, $\zeta_{FO\to TO} = \left[\frac{\zeta_{TO}\zeta_{Tec}^\beta M_f^{1-\beta}}{\zeta_r^{\alpha\beta} Dis} Y_d^\gamma Y_f^{1-\gamma} \right]^{1/(1-\omega)}$.

As can be seen from the above equation, after technical intermediary, financial openness is to play a positive role in promoting trade openness. The importance of the role is not only influenced by the above coefficient $\zeta_{FO\to TO}$, but also affected by $\lambda\alpha\beta/(1-\omega)$.

Then look at the way how trade opening influences financial openness. Financial openness is affected by the technical level, and technical level can be influenced by trade openness, so, the function describing the influence changes as follows:

$$\begin{aligned} FO &= \zeta_{FO} M_d^\varphi = \zeta_{Tec\to FO} Tec^\varphi \\ &= \zeta_{FO} M_d^\varphi = \zeta_{FO}\zeta_{Tec}{}^\varphi \frac{TO^{\omega\varphi}}{r^{\alpha\varphi}} = \zeta_{FO}\zeta_{Tec}{}^\varphi \frac{TO^{\omega\varphi}}{\zeta_r^{\alpha\varphi} FO^{-\lambda\alpha\varphi}} \\ &\Rightarrow FO \left[\frac{\zeta_{FO}\zeta_{Tec}{}^\varphi}{\zeta_r^{\alpha\varphi}} \right]^{1/(1+\lambda\alpha\varphi)} TO^{\omega\varphi/(1+\lambda\alpha\varphi)} = \zeta_{TO\to FO} TO^{\omega\varphi/(1+\lambda\alpha\varphi)} \end{aligned} \quad (5)$$

Where $\zeta_{TO\to FO} = \left[\frac{\zeta_{FO}\zeta_{Tec}{}^\varphi}{\zeta_r^{\alpha\varphi}} \right]^{1/(1+\lambda\alpha\varphi)}$, $\zeta_{Tec\to FO} = \zeta_{FO}$, and FO is the financial openness.

As can be seen from the equation, after technical intermediary, financial openness is affecting trade openness. And the degree of the effect is not only influenced by the above coefficient $\zeta_{FO\to TO}$, but also affected by $\omega\varphi/(1+\lambda\alpha\varphi)$.

We can draw the conclusion from the above theoretical analysis of trade openness, technology, financial openness that trade openness can introduce new technology and competition, promoting the domestic technological progress. The improvement of the bilateral technology level will enlarge the differences between the two country's development directions, thus promoting the inter-industry trade. Through improving the operating efficiency of the financial system, spreading risks and seeking for product innovations, technology progresses, changing of the financial structure, grasping the comparative advantage and forming the condition for financial opening. Through optimizing the allocation of resources, financial opening encourages technological innovation and reduces the opportunity cost, thus promoting technological progress and then improving the production efficiency. The enrichment of product category, or to say, the strengthening of the comparative advantages increases trade opportunities.

2 The Index Selection and Empirical Analysis

This article only analyze the economic entity belonging to the Organization for Economic Cooperation and Development (OECD), mainly because these entities are mostly economically developed countries and they have experienced more complete economic development stages than developing countries, so these countries can better reflect the law of economic development. In order to meet the characteristics of industrial transfer, in this paper, some developing countries are added when studying industrial transfer. Developing countries have yet experienced the transferring process of development, maturity, fading of the manufacturing industry and, at the same time, their high technology industry is still in its infancy, so they can't absolutely response the complete process today's world economy has experienced.

2.1 The Trade Openness Indicator

Trade openness measure indexes are mainly used for measuring the degree of trade openness. In this section, as to the trade openness, we still use the common practice, that's to say, we use the ratio of import and export volume to the country's gross domestic product (GDP) as the trade openness, and the data come from the OECD. From the graph, we can see that there exists great differences among the OECD countries as to trade openness, and this can explain two questions.

That is, on the one hand, the share of the total import and export trade volume in GDP can vary greatly in different countries and direct comparison of trade openness has some problems. This agrees with S. Kuznets's (1989) discoveries in his study, that's to say, there is a negative correlation relationship between the ratio of the international trade volume to GDP and the national income. And this also agrees with the conclusion that the share of the international trade volume in GDP has a u-shaped correlation relationship with the country's gross domestic product.

On the other hand, the trade openness calculated using this algorithm grows slowly with time and this suggests the value of using this indicator. And the term "Average" represents the annual average of the trade openness of all OECD countries.

2.2 The Financial Openness Indicator

The degree of opening to the outside world is described as the "breadth" or as the "depth". In this paper, we make some partial adjustments about the financial openness indicator used by Jiang Boke (1999).

The computation formula is as follows:

$$FO = (DDI + FDI)/GDP + SI/GDP + OI/GDP + NACB/TACB \quad (6)$$

Where, *FO*: Financial openness; *DDI, FDI*: foreign direct investment and the foreign direct investment on domestic; *GDP*: The gross national product; SI: Securities investment, including the country holding foreign securities and foreign securities held for their; *OI:* In addition to total other investment securities and foreign direct investment, including native to other investment and foreign to domestic investment; *NACB*: The central bank net foreign assets; *TACB*: The central bank total assets.

2.3 The Technical Effect Indicator

The technical effects will be divided into two parts in this paper, namely the technical effects of objects and technical effects of knowledge. In this paper, from the perspective of data availability, we select per thousand per capita authorized patent number as the materialized technology and use the share of people who have been highly educated in the labor force as the knowledge technology. The patent number is determined according to the statistical data of the European Patent Office (EPO) in the OECD, and the ratio of highly educated labor is taken from the WDI database.

The technical effects are expressed by the per thousand per capita authorized patent number(patent); the human capital is expressed by the ratio of the labor force who have received the tertiary education(edu); the industrial transfer(transfer) is represented by the ratio of service sector output and the industrial output of the country in related years; the scale effects(scale) are expressed by the ratio of the formation value of the fixed capital and the total sum of added value of the three industries. Financial openness and trade openness will be respectively described in Sects. 4.1.1 and 4.1.2. The level of research and development (research) is measured by the share of the country's R&D investment in GDP. $patent_{it}$, $research_{it}$, edu_{it}, $finance_{it}$, $trade_{it}$, $transfer_{it}$, $scale_{it}$ represent the technological level, the R&D level, the human capital level, financial openness, trade openness, the industrial transfer and the scale effects. Where, i = 1,2, . . . ,N, the letter 'I' represents different countries, and "N" is the individual number of the panel data; t = 1,2, . . . ,T, 't' represents different years and 'T' is the maximum length of the time series. In this section, the empirical data last from the year 1985 to 2008.

Table 1 Unit root test

Variables	Order	Test method	Value of statistics	P	Cross sections	Observations
Research	0	IPS-W-STAT	0.83503	0.7982	28	274
		ADF	52.8672	0.5942	28	274
		PP	79.3743	0.0217	28	281
Research	1	IPS-W-STAT	−6.762	0	26	241
		ADF	136.119	0	28	247
		PP	162.05	0	28	252

According to the previous assumptions, we can establish the following regression model:

$$
\begin{aligned}
patent_{it} = a_i &+ \sum_{j=1}^{T} \beta_{0,t-j} patent_{i,t-j} + \sum_{j=0}^{T} \beta_{1,t-j} research_{i,t-j} \\
&+ \sum_{j=0}^{T} \beta_{2,t-j} edu_{i,t-j} + \sum_{j=0}^{T} \beta_{3,t-j} finance_{i,t-j} + \sum_{j=0}^{T} \beta_{4,t-j} trade_{i,t-j} \\
&+ \sum_{j=0}^{T} \beta_{5,t-j} transfer_{i,t-j} + \sum_{j=0}^{T} \beta_{6,t-j} scale_{i,t-j} + e_{it} \qquad (7)
\end{aligned}
$$

$$i = 1,2,\ldots,N; t = 1,2, \ \ldots, T;$$

α is a constant, β_0, β_1, β_2, β_3, β_4, β_5 respectively for the coefficients corresponding item, e_{it} residuals. Numerical 31 countries from 1985 to 2008, the numerical OECD. The variables in the previous chapters have a unit root test, for a smooth, establish panel model. Unit root test corresponding variables has pasted. Unit root tests found that all regression variables for a smooth as shown in Table 1, has conducted a panel regression, excluding some insignificant variable results obtained as shown in Table 1.

After using the unit root test we find that all the regression variables are first-order stationary, so we use the panel regression method to get rid of some variables whose effects are not significant and the result is shown in Table 2.

Similarly, test the model with Hausman method and we found it refuses the original assumption, that is, the random utility model is not suitable for this model, so here we select the fixed-effects regression model for empirical analysis, the detailed data will be shown in the last line of Table 2.

As can be seen from the empirical analysis, technological level is mainly promoted by their investment in research and development. Although trade openness and financial opening also have a positive role in promoting technological level, their effects are relatively weak. We didn't find that the scale effect and industry

Table 2 The fixed effects model of technical effects

	Dependent variable: scale effect			
Controlled variable	Value	Standard deviation	T Statistic	Value P
Constant coefficient	−0.00019	0.013945	−0.01393	0.9889
Patent(−1)	0.715405	0.037339	19.15993	0
Research	0.016843	0.00707	2.382218	0.0181
Research(−1)	−0.00984	0.007042	−1.39735	0.1637
Finance(−1)	0.000283	9.42E−05	3.006302	0.003
Trade	0.000231	0.000109	2.121752	0.035
Trade(−1)	−0.00014	0.000117	−1.23102	0.2197
Transfer	0.001391	0.004019	0.346008	0.7297
Scale	0.017178	0.027332	0.628509	0.5303
R-Squared	0.993942	F-statistic	1,102.262	
ADJ. R-squared	0.99304	PROB(F-STAT.)	0	
Durbin-Watson stat		1.880807		
Hausman test	CHI-SQ. statistic		99.3014	0

Note: The table is omitted in the constant coefficient value of each country

transfer have significant influences on the technical level. This can be interpreted as follows: the scale effect has formed R&D advantage, thus promoting the progress of technology level.

The uncertainty how industry transfer influences technical progress is mainly because in this study phase the OECD countries are mainly industrial exporters, and they have no effect on domestic technological progress but significant impact on the countries concerned. Specifically, once the investment in R&D increases by one unit, the technology level will increase by 0.017 units. And each unit of financial openness growth in the last phase will lead to 0.03 % units' increase in technological level. Also, each unit of increase in trade openness will also lead technological level to increase by 0.02 % units. The effect of other variables on the technical level is not significant.

3 Conclusions

The technical effect has positive influences on trade openness, and the effect caused by the technological progress is more obvious. The level of technology has positive influences on financial openness, and the effect caused by the technical effect is greater. In OECD countries, technological level is mainly promoted by their investment in research and development. Although trade openness and financial opening also have a positive role in promoting technological level, their effects are relatively weak and the promotion effect caused by financial opening will delay for 1 week.

And then the interactional relationships of trade openness, financial openness and technological progress in developing countries and developed countries. The leading level and the accumulation of experience in the high technology and financial industry grant them absolute advantages in the international market and in the high-end fields. What's more, the roll-out of the manufacturing industry provides low-cost labor for high technology industry and the financial services further.

As to developing countries, it is a different story. On the one hand, developing countries have to accept the manufacturing industry left by the developed countries, but on the other hand, they can develop their own technology during the industry transfer by means of learning. But because of their backwardness of the financial and trade level, it is difficult to surpass the developed countries in a short period of time.

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The Whole Interaction of Trade Openness, Financial Openness and Scale Effect

Feng-wu Han and Xiang-song Meng

Abstract Based on classic model (Do and Levchenko, J Financ Econ 86(3):796–834, 2007), the single factor is adjusted to the two model, and the mechanisms of interaction between trade openness, financial openness and the scale effect are proved by theory. Through the empirical analysis of the OECD and major developing countries, the paper explains the different effect of the interaction between different stages of economic development and open economy.

Keywords Financial openness • Trade openness • Scale effect

1 Introduction

The scale effect in theory can be divided into three types, namely economies of scale, diseconomies of scale, scale invariant. The economies of scale (Economics of Scale), may go by the name of "scale benefit".

Study on the interaction between the reduced scale effect and financial openness about trade liberalization of the financing cost of production, the article from the Kletzer and Bardhan (1987) and Beck (2002) model and Do and Levchenko (2007) elements of the original model into the open after a simple expansion. Do and Levchenko (2007) model that international trade makes a particular industry because of the existence of economies of scale, so it increases the demand of funds, high quality financial system and requirements can reduce the financing cost and liquidity shocks exist, the introduction of external competitors in an economic body of existing financial system in order to achieve a more the market demand will produce. Kletzer and Bardhan (1987) model for illustrating the liquidity shocks

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and efficient financial market can help enterprises to reduce transaction costs, coping with capital market, thus the effect of economy of scale to establish relative advantage.

2 Theoretical Analysis

Based on the original model of Do and Levchenko (2007), the original single elements is adjusted to the two model, the remaining unchanged. Assume that there is an economic body, it has the elements of land and Labor. The production of a kind of capital depends on the type of two goods of product F and a simple commodity A.

Time interval is made up by successive time intervals of ,Consumption takes place at the end of time interval time $t \in [0,1]$. The utility function using two commercial Cobb-Douglas form:

$$U\left(c_F, c_A\right) = c_F^{\alpha} c_A^{1-\alpha} \tag{1}$$

Now with A as the numeraire commodity, then the relative price of the commodity F is p_F. According to the utility maximization principle, the relationship between relative prices directly we can draw a conclusion that consumption and products:

$$p_F = \frac{\alpha}{1-\alpha}\frac{c_A}{c_F} \tag{2}$$

Suppose that the market is perfectly competitive, free access to the production of F or any one industry. Entrepreneurs make decisions at the time of starting point. The production of these two sectors take place in the continuous period $t \in [0,1]$. To simplify the calculation, it is assumed that the element of land and labor factor can completely replace or invest in fixed proportions, the combination of elements of L, called the combination of elements. Set A as linear technology output function, so according to the profit maximization theory, $p_A = w = 1$ can be obtained. If a unit of labor wages is w.

F is a kind of dependence on external financing products, assuming that the unit of output also need comprehensive elements of L unit. So the product F industry project continuous rate of return is $(R_t)_{t \in [0,1]}$, In each time period, the project by the liquidity shock λ_t, the expression for the: $\tilde{\lambda}_t = \begin{cases} \lambda & w/prob.\,(1/2) \\ -\lambda & w/prob.\,(1/2) \end{cases}$.

In the formula λ is a positive constant. The assumption here in time for all companies shocks are independent and identically distributed. If at the time of $[t, t+dt]$, liquidity shock is positive, or liquidity needs to be realized, then the project proceeds Rdt. Otherwise, at that time the income is 0.

There is demand for liquidity providers need to borrow to meet liquidity. There is a spot credit market in each time $[t, t+dt]$, the excess capital entrepreneurs need to borrow on the current market interest rates to the shortage of liquidity manufacturers. The period of the debt contract will be at the end of time interval and return. The assumption here, market liquidity is determined by the supply and demand of liquidity. If the liquidity shock is positive, then there is a transition of financial supply, interest rate will be 0. On the other hand, if the liquidity shock is negative, the lenders receive all the income to the F production project, that is $r_t\lambda dt = p_F R dt$. In the latter case, in order to obtain the liquidity in the enterprise is a time of return rate of 0.

Now assume that η is used in the industry of integrated elements of the proportion of F. Then the number of the industry's total company is ηL, $i \in \{1, \ldots, \eta L\}$. And for the time period γ_t are clearing out a project in $[t, t + dt]$ ratio, its value is:

$$\gamma_t = \begin{cases} \frac{1}{\lambda \eta L} \sum_{i=1}^{\eta L} \tilde{\lambda}_t^i & if \sum_{i=1}^{\eta L} \tilde{\lambda}_t^i \\ 0 & otherwise \end{cases} \tag{3}$$

At time t, the liquidity impact of the economies of all industry company in F is $\sum_{i=1}^{\eta L} \tilde{\lambda}_t^i$. If the value is positive, said no project by liquidity shock and collapse, if negative, indicating a certain amount of company due to impact, depends on the size of aggregate shocks. The possibility that project impact probability and failure is random, then F accumulated output to $R[1 - \gamma(\eta L)]$, $\gamma(\eta L) \equiv \int_0^1 \gamma_t dt$. F industry enterprises to maximize profits, product F price equal to its unit cost: $p_F R[1 - \gamma(\eta L)] = w = 1$ and $c_A = (1 - \eta)L$.

The model shows that the equilibrium value, $\gamma(\eta L)$ refers to the liquidity shock is not external financing caused the loss of output of the proportion of enterprises, $1 - \gamma(\eta L)$ is to obtain external liquidity enterprises. While the financial system's quality and engaged in F industry production enterprises the proportion of W positive correlation. When the quantity is engaged in F industry enterprises increased, in a given range of the negative impact of the probability is small, the enterprise liquidation is less. The function $\gamma(\eta L)$ can be used as the function of quality of the financial system, from its definition can be obtained as a decreasing function, and the presence of $\gamma(1) = 1/2$, $\lim_{\eta L \to \infty} \gamma(\eta L) = 0$.

In a closed economy, is a measure of the economic structure of the index, the market clearing conditions mean that consumption equals output:

$$c_F = R\left[1 - \gamma\left(\eta L\right)\right] \eta L \tag{4}$$

Thus, we conclude that the form of product distribution: $\eta^A = \alpha$.

In each time period $t \in [0,1]$, assumption for received positive impact of the number of enterprises, then $\eta L - k$ is a negative number to the impact of the enterprise. If $k > \eta L - k$, then the period of the loan amount to $\lambda(\eta L - k)$. On the contrary, it can borrow a total of $\lambda(k)$, economy has been hit by a liquidity constraint:

$$PrivateCredit = \lambda \left[\sum_{1}^{\eta L/2} kP(k) + \sum_{\eta L/2+1}^{\eta L} (\eta L - k)\, P(k) \right] \tag{5}$$

K is a binomial random variable probability by 50 %, total amount is ηL, so the equation can be simplified as:

$$PrivateCredit = \frac{1}{2}\lambda \eta L \tag{6}$$

It can be seen from the above equation is proportional to the external dependence on external finance industry.

Now suppose that two countries N and S. Endowment integrated elements of their respectively for L^N and L^S, existence of productivity differences is Ricardo in F industry between them is $R^N > R^S$. And assuming that N is the only production of F products in the trade equilibrium state. So as long as the determined N country into comprehensive elements industry F, the proportion of η^N can product structure determine the equilibrium. At this time, the market conditions for the:

$$c_F = R^N \left[1 - \gamma \left(\eta^N L^N\right)\right] \eta^N L^N \tag{7}$$

and

$$c_A = \left(1 - \eta^N\right) L^N + L^S \tag{8}$$

From the above two equations can be obtained when the resource allocation scheme for equilibrium:

$$\eta^N = \alpha \frac{L^N + L^S}{L^N}, \text{when } \eta^N \leq 1 \tag{9}$$

Clearly, if W is large enough, or the K is small enough, the above condition is very easy to meet. For example, two kinds of products for the Consumer basket accounted for the same $\alpha = 1/2$, factor endowments and the two countries of the same $L^N = L^S$. There will be $\eta^N = 1$. At this moment there is not the credit in the S.

From the above four equations can be seen, after the trade opening $\eta^N > \eta^S$, the N has more credit, this also means that the product of the financial system supply effectively increase, because $\gamma(\eta^N L^N) < \gamma(\eta^A L^N)$. The increase in supply in two ways: one is the gradual development of the accumulation of capital in the domestic financial industry and raise capital for conversion to solve; second, through the financial opening for the supply in market. A short period of time, the latter is far more potential and effects, though probably because of mismanagement caused the financial crisis. Baltagi et al. (2009) pointed out that the financial opening is one effective way of financial development. So the two ways can be satisfied by the financial openness, because financial development and direct financing also constitute the financial opening demand. When more and more manufacturing companies to enter the F industry, the formation of scale economy, external financing needs cannot be achieved enterprises declined, financial development has deepened, financial openness has also expanded.

So from the above conclusion shows, trade openness makes economy of scale industry to play, this time need higher quality financial system to meet the needs of financial openness will emerge as the times require, in this condition.

If a country's financial openness makes the country's financial product competition is more intense, improves the relative efficiency of financial system, the country's more dependent on capital has the scale effect of the industry will get faster development, because its comparative advantage, and then changed the size and structure of the current international trade, and promote the trade openness. For those developed countries and financial development has been particularly useful for a certain level of developing countries. Financial liberalization makes the domestic financial intermediaries and financial system and development driven by market competition mechanism, this mechanism allows all industry benefit, but for those with economies of scale enterprises benefit more.

3 Empirical Analysis

The empirical analysis of the organization for economic cooperation and development (OECD) of the economies in this paper. The main reason is the OECD countries are mostly developed countries, experience the stage of economic development than the developing countries must be complete, can reflect the law of economic development. In this paper, on the research of the transfer of industry also joined in some developing countries, in order to meet the characteristics of industrial transfer itself. Developing countries have not experienced the development of manufacturing industry, mature, rate come to transfer process, at the same time, the development of high-tech industry is in the primary stage, the complete process cannot complete reaction of the world economy experienced.

Index of trade liberalization is mainly used to measure the degree of trade openness. Trade openness in this section is still used in practice, namely the choice of the total import and export volume accounted for the country's gross domestic product, data from the OECD organization, the results in Fig. 4.1. As can be seen from the graph, OECD is the same country, trade openness can vary greatly, and this shows that two issues. On the one hand, with import and export trade volume accounted for the proportion of GDP, the difference value of different countries can be very large, direct comparison between trade openness has some problems, this and S. Kuznets (1989) study found, namely the rate of international trade and GDP and press between national income measure country size has a negative correlation relationship, consistent relationship also exist some similar to the U type and the country's gross domestic product. On the other hand, computing the same countries trade with the calculation method of openness in along with the time growth was

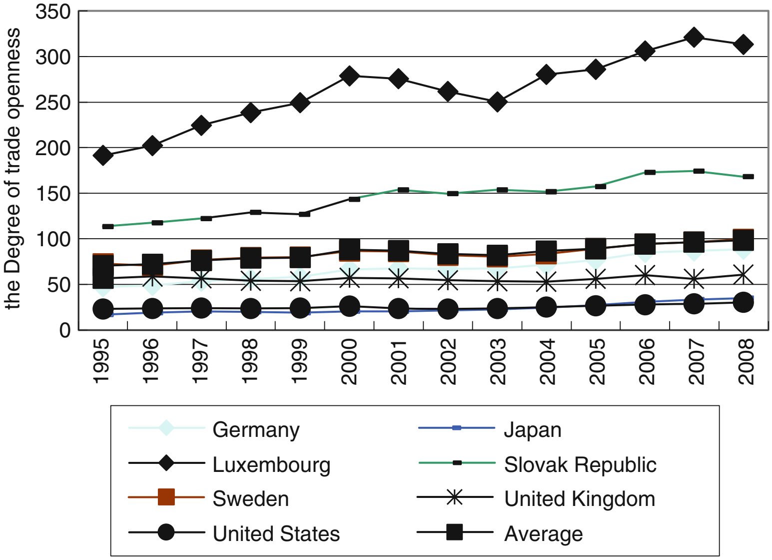

Fig. 1 The degree of trade openness

slow growth [detailed data can refer to Fig. 1], indicating that the index value. The Average term represents the mean of all OECD countries trade openness of year. The Average term represents the mean of all OECD countries trade openness of year.

The degree of opening up, one is the "breadth", another is "depth". In this paper, Jiang Boke (1999) defines the financial openness index adjustment, then the volume again. The calculation formula is as follows:

$$FO = (DDI + FDI)/GDP + SI/GDP + OI/GDP + NACB/TACB \qquad (10)$$

Where, *FO*: Financial openness; *DDI, FDI*: foreign direct investment and the foreign direct investment on domestic; *GDP*: The gross national product; SI: Securities investment, including the country holding foreign securities and foreign securities held for their; *OI:* In addition to total other investment securities and foreign direct investment, including native to other investment and foreign to domestic investment; *NACB*: The central bank net foreign assets; *TACB*: The central bank total assets.

Index scale effect from Michael Thorpe and Zhaoyang Zhang (2005), the total assets and the first (Agriculture), second (industry), the tertiary industry (service industry) the increase in the ratio of value as a proxy measure of effect size. Seen from Fig. 4.6 can also, the period since 1970 to 2008, from a part of the OECD national [because of the economic data of some OECD countries early no statistics.]

Table 1 Relationship between transverse industry scale economy and industry, internal, vertical intra-industry trade

Variable quantity	Intra-industry trade	Horizontal intra-industry trade	Vertical intra-industry trade
Production capacity	0.0161 (1.8941)*	0.0374 (4.9867)***	−0.0147 (2.0704)**

Note:

1. *, * * and * * * in the table, are significant at the 10 level, 5 and 1 % level. The rest of the original variable regression. The amount saved. The brackets data bit numerical line regression, the data in brackets for the t statistic value
2. The data in this table are picked from Michael Thorpe and Zhaoyang Zhang (2005) in Table 2

Production scale gradually improved, although the growth rate is relatively small. From Table 1, from the angle of statistics confirmed, 39 years production scale sequence first-order stationary, indicating the presence of increasing with time significant trend of the sequence. Due to the macro variables reflect the change of scale economies slow, so that it can only in a relatively long time to reflect. This stage, if the use of political economics point of view, it is the so-called by the free competition capitalism to monopoly as the main characteristics of the imperialist transition. At the same time, this paper gives the trend chart scale effect of different types of countries around the world, due to lack of statistical data, complete can be used for comparison only from 2000 to 2006 data period. From the graph we can see, with the development of global economy, the scale economy effect of various types of countries are on the rise, although there are repeated, but the overall trend in growth. Findings from some types of national longer data, the 1997 financial crisis, and economies of scale countries all have relatively obvious decline, due to limited space not to be shown in this paper.

Very difficult to choose the size effect of macroeconomic indicators. The selection of the index of two main factors, one is based on the existing literature, Marx is the two labor twoness doctrine based on.

Michael Thorpe and Zhaoyang Zhang (2005) found on East Asia economies of scale in the region can effectively promote the increase of horizontal intra-industry trade in the empirical data from 1971 to 1996, the vertical intra-industry trade is inhibited, but relatively small amounts, from an overall perspective is still positive correlation, the limited when measuring the industrial scale data availability, the total fixed capital formation by industrial added value ratio as a proxy to represent, the empirical results in Table 1.

Labor twoness doctrine based on, Marx quotes from Chinese version of "capital", Marx have seen the reference entry. He pointed out that, with the development of capitalism, will result in the increase of the capital organic composition, especially in the industrial field. This increases the product of constant capital return on investment and human capital returns ratio. The relative increase in constant capital investment, means to produce more surplus value and more capital accumulation, thus improving the economic scale of industry.

The above two factors based on the index, with assets and the amount of the first (Agriculture), second (industry), the tertiary industry (service industry) the increase in the ratio of value as a proxy measure of effect size.

According to the theory, this section with trade openness, financial openness, the effects of technology and industry transfer four explanatory variables to explain the size effect.

The number of technical effect per thousand per capita patent technology (*patent*) and human capital are chosen to accept third grade education labor population ratio (*edu*) said. Industrial transfer (*transfer*) is the ratio of the corresponding service industry output value of industrial output each year and said. The scale effect (*scale*) is used to form the corresponding fixed assets each year and increase three industry ratio and said. Financial openness are described in the formula (10).

Trade openness measure indexes are mainly used for measuring the degree of trade openness. In this section, as to the trade openness, we still use the common practice, that's to say, we use the ratio of import and export volume to the country's gross domestic product (GDP) as the trade openness, and the data come from the OECD. The result is shown in Fig. 1. From the graph, we can see that there exists great differences among the OECD countries as to trade openness, and this can explain two questions.

That is, on the one hand, the share of the total import and export trade volume in GDP can vary greatly in different countries and direct comparison of trade openness has some problems. This agrees with S. Kuznets's (1989) discoveries in his study, that's to say, there is a negative correlation relationship between the ratio of the international trade volume to GDP and the national income. And this also agrees with the conclusion that the share of the international trade volume in GDP has a u-shaped correlation relationship with the country's gross domestic product.

Using $patent_{it}$, edu_{it}, $finance_{it}$, $trade_{it}$, $transfer_{it}$, $scale_{it}$ identifier representation technology, human capital, financial openness, trade openness, industrial transfer, scale effect. Among them, $i = 1, 2, \ldots, N$, i indicate different countries, N indicates the number of individuals contained in panel data; $t = 1, 2, \ldots, T$, t indicate different years, t indicate the maximum length of time series. The empirical data of this section of the choice from the beginning of 1985 to 2008 at the end of the year.

According to the previous assumption, the following regression model:

$$\begin{aligned} scale_{it} = a_i &+ \sum_{j=1}^{T} \beta_{0,t-j} scale_{i,t-j} + \sum_{j=0}^{T} \beta_{1,t-j} patent_{i,t-j} + \sum_{j=0}^{T} \beta_{2,t-j} edu_{i,t-j} \\ &+ \sum_{j=0}^{T} \beta_{3,t-j} finance_{i,t-j} + \sum_{j=0}^{T} \beta_{4,t-j} trade_{i,t-j} \\ &+ \sum_{j=0}^{T} \beta_{5,t-j} transfer_{i,t-j} + e_{it} \end{aligned} \tag{11}$$

Table 2 The fixed effect model scale effect

	Dependent variable: scale effect			
Controlled variable	Value	Standard deviation	t Statistic	Value p
Constant coefficient	0.030227	0.00937	3.226057	0.0013
Scale(−1)	0.808613	0.02428	33.30332	0
Patent(−1)	−0.01527	0.024601	−0.62078	0.535
Finance	0.000194	0.000147	1.313303	0.1896
Finance(−1)	1.93E-05	0.000151	0.128129	0.8981
Trade	−0.00029	0.000162	−1.80007	0.0724
Trade(−1)	0.000343	0.000163	2.099995	0.0362
Transfer	−0.03571	0.008746	−4.08351	0.0001
Transfer(−1)	0.042147	0.009071	4.646202	0
R-Squared	0.897505	f-statistic	138.1029	
Adj. R-squared	0.891006	Prob(f-stat.)	0	
Durbin-Watson stat		1.684152		
Hausman test	Chi-sq. statistic		34.78589	0

Note: Table omitted in each section countries often coefficient

α is a constant, β_0, β_1, β_2, β_3, β_4, β_5 respectively for the coefficients corresponding item, e_{it} residuals. Numerical 31 countries from 1985 to 2008, the numerical OECD. The variables in the previous chapters have a unit root test, for a smooth, establish panel model. Unit root test corresponding variables has pasted. Unit root tests found that all regression variables for a smooth, has conducted a panel regression, excluding some insignificant variable results obtained as shown in Table 2.

The same Hausman test was performed on the model, the reject the null hypothesis, that the model is not suitable for the random utility model, so the empirical choice is the fixed effects model.

From the empirical research can be seen, the scale effect is mainly affected by itself and trade openness, industrial transfer and positive effect, effect of other factors on it were not. Impact of trade openness in the scale effect is negative, although its role is only 3/10,000, but is the positive influence on the next stage, the effect of slightly more than 3/10,000 point four, larger than a role, namely comprehensive effect is positive. Industrial transfer on the scale of the role of the same trade openness. Industrial transfer a unit of each growth period, the scale effect will be reduced by 0.04 units, but a positive effect on the next stage, the size of 0.42 units, the comprehensive effect is positive. Effect of financial openness on the scale effect is not significant, mainly because of financial opening to provide financial support for the expansion of the scale, member of OECD organization, in the financial opening before the majority belongs to domestic capital abundant country, they mainly through the financial opening the capital output instead of attracting funds, hence the empirical results. Effect of technology effect on the scale effect should also not significant, this is mainly because of the country's technology progress to provide a higher rate of return on capital, reduce power enterprises pursue profits through scale effect. Technology innovation, will form a new industry and growing, while existing industry with the development of new industry is gradually squeezed out, the formation of industrial transfer phenomenon.

4 Conclusions

Trade openness is the scale of the positive role. Financial openness is also affected by the economy of scale and positive effect. The scale effect on financial openness promotes strong. The scale effect is mainly affected by itself and trade openness, industrial transfer and positive effect, the impact of financial openness on it is not significant. The impact of trade openness in the scale effect is negative, a period of lag influence is positive, the comprehensive effect is positive.

Then the relationship between trade openness, financial opening, the scale effect between developing and developed countries. Because the recipient country manufacturing industry financial openness makes the developed countries can go to the transfer of funds, low cost, but the scale economic benefit from the industry rapidly from domestic to foreign.

For the developing countries is another story. In the developed country manufacturing industry transfer out at the same time, temporary sacrifice future opportunities promising high-end technology and financial industry, this is the general law of development, is also with trepidation.

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Study on Measurement of Eco-efficiency of Beijing-Tianjin-Hebei Metropolitan Region

Wen-bao Sun and Jing Peng

Abstract Eco-efficiency is an important index on measuring sustainability status and circular economy development. As an important growth-pole of China's economy in the twenty-first century, Beijing-Tianjin-Hebei Metropolitan Region has been facing the increasingly serious resources and environment problems with industrialization. Based on the related data from 2006 to 2008, the paper measures the eco-efficiency and input surplus of ten cities in Beijing-Tianjin-Hebei Metropolitan Region by DEA method, and then points out the improvement direction for the invalid cities. By the research, the paper aims at promoting ecological construction of the region and the country.

Keywords Beijing-Tianjin-Hebei Metropolitan Region • Data envelopment analysis • Eco-efficiency

1 Introduction

World economic history shows that there is a strong correlation between the economic growth and the change of economic structural, and the economy develops with the constant change of economic structure. With the 30 years of China's reform and opening up, China experienced the rapid development of industrialization and urbanization, and the problem on the resource and environment constraints to the economic development is more and more serious. Statistics showed that China's GDP growth rate in 2006 was 10.5 %, while the GDP energy consumption at that year was 1.21 millions tons of standard coal, which was 3–11 times of that in developed countries. Moreover, according to the measure and calculation of the

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World Bank and the domestic sector, in the mid-1990s of last century, the 2/3 economic growth in China lied in the overdraft to the entironment. It has been recognized that the extensive economic growth model of high energy consumption and high pollution has come to the end. In the age of ecological constraints with relatively scare natural capital, it has become the important issue of economic growth transformation and circular economy development to seek for the effective compatibility and harmonious development of industrial system and environment (Zhou Guomei et al. 2003; Zhu Dajian and Zhu Yuan 2005).

Beijing-Tianjin-Hebei Metropolitan Region is becoming the third growth pole of China economy by natural geographical advantage and good economic foundation. In accordance with the concept of the National Development and Reform, "Beijing-Tianjin-Hebei Metropolitan Regional Planning", Beijing-Tianjin-Hebei Metropolitan Region includes two municipalities, which are Beijing and Tianjin, and eight cities from Hebei Province, which are Qinhuangdao, Tangshan, Langfang, Baoding, Shijiazhuang, Cangzhou, Zhangjiakou and Chengde. Such region is not only the most important political and cultural center in China, but also the biggest and highest level economic core area in north China, which is the important hub and gateway for China's participation in international economic exchanges and cooperation as well. However, the region takes the manufacturing development model and lakes of adequate understanding on the coordinated development relationship between the industrial system and the environment. All of these make the resource and environment have become the more and more serious issue for the area's development, and how to achieve industrial upgrading and sustainable development also is becoming the key to obtain new growth momentum in the region. Taking into account the difficulties being faced by the region is universal in China, the study on the region's eco-efficiency between different cities has important reference value not only for such region but also the whole nation. Accordingly, this paper evaluated and analyzed eco-efficiency among the cities of Beijing-Tianjin-Hebei Metropolitan Region by DEA models to understand the effect of industrial growth to the ecological environment in the region.

The second part mainly introduced the concept of eco-efficiency and briefly described DEA model, which also explained the index design. The third part is the specific empirical analysis. Finally the paper made a brief conclusion.

2 Methodology

The concept of eco-efficiency (Stigson 1999) is from ecological economics, which was first proposed by Schaltegger and Sturm in 1990. Later OECDE (economic Cooperation and Development Organization) and the WBCSD (World Business Council for Sustainable Development) began to promote and implement this concept in their project, which makes the concept of eco-efficiency widely recognized and accepted. The reason why eco-efficiency become more and more popular on the one hand is due to increasingly stringent environment legislation, and on the other hand is due to enterprises environment behaviours' affect to their Public image and financial performance (Konar and Cohen 1997). Therefore, eco-efficiency has become an important part of the competitive strategy.

In general, eco-efficiency means the ability to bring the least environmental impact during producing goods and services (Yoshinori Kobayashi et al. 2005). From the empirical point of view, eco-efficiency usually can be described as: the increase in economic value divides by the level of environmental damage. While eco-efficiency definition is clear and intuitive, its actual quantitative assessment is still often vague. On the one hand, many evaluating indicators are often alternative; on the other hand, the purpose of evaluating eco-efficiency is to provide the necessary information for decision-making, and therefore it must ultimately form a single standard for decision-making on the different dimensions assessment of eco-efficiency (Timo Kuosmanen and Mika Kortelainen 2005). Based on this consideration, many scholars take DEA (Data Envelopment Analysis) method to evaluate eco-efficiency.

DEA method was first used to evaluate performance when there are multiple performance standards, which is widely used in the public sectors and non-profit organizations (Dyckhoff and Allen 2001; Lv Bin and Yang Jianxin 2006). There are two reasons why the method is very suitable for eco-efficiency evaluation. The first one is that is could well explain the alternative possibilities of different performance standards. The second one is that such method is automatically empowered with statistical methods, which could avoid the impact of subjective empowerment.

The basic principle of DEA methods is below: the multiple inputs and outputs' project data of decision-making is projected in the coordinate space, find the maximum outputs or minimum inputs as efficiency border to measure the efficiency of each DMU (decision-making unit). If the observed number of DMU falls on the efficiency boundary, then it is considered that the DMU is relatively efficient, and its efficiency value is 1. Or it is considered relatively inefficient, and its efficiency value is between 0 and 1, the gap represents the inefficient extent of such DMU.

Based on this principle, Charnes, Cooper and Rhodes proposed C^2R model by linear programming in 1978 (Charnes et al. 1978; Sheng Zhaohan 1996). Suppose there are *n* DMU_j s, and each DMU_j has *m* inputs types and *s* outputs types, then the C^2R model with non-Archimedean infinitesimal can be expressed as:

$$\min\left[\theta - \varepsilon\left(\widehat{e}^T s^- + e^T s^+\right)\right] = V_D(\varepsilon)$$

$$s.t.\begin{cases} \sum_{j=1}^{n} \lambda_i x_j + s^- = \theta x_0 \\ \sum_{j=1}^{n} \lambda_i y_j - s^+ = y_0 \\ \lambda_j \geq 0, \quad j = 1\cdots, n \\ s^- \geq 0, s^+ \geq 0 \end{cases}$$

Table 1 Eco-efficiency evaluation index of Beijing-Tianjin-Hebei metropolitan region

	Index	Meaning
Input index	Industry power consumption	Resource consumption indicators
	Industrial Energy Consumption	
	Industrial Water consumption	
	Industrial waste water	Environmental impact indicators
	Industrial SO_2 emissions	
	Industrial soot emissions	
Output index	Total industrial output value	Industrial output

Where, x_j means input variables, y_j means output variable. ε is non-Archimedean infinitesimal, which is an abstract mathematical concept, is a number less than any positive number and larger than zero. $\widehat{e}^T = (1, 1, \cdots, 1)^T \in R^m$, $e^T = (1, 1, \cdots, 1)^T \in R^s$, s^- and s^+ are respectively surplus variable and slack variable, which λ_j is coefficient vector and θ is parameter.

Let the optimal solutions of the planning problems are $\lambda*, s^{*-}, s^{*+}, \theta*$ and

If $\theta* = 1$, then DMU_j is weak DEA efficient;
If $\theta* = 1$, and $s^{*-} = 0$, $s^{*+} = 0$ then DMU_j is DEA efficient.

Furthermore, it can also carry on the analysis of investment redundancy rate and output underemployment rate for the non-DEA efficient DMU to improve DMU. Investment redundancy rate is defined as the ratio of s_j^- and x_j of DMU, which means proportion to be saved for the investing component indicator. And the ratio of s_j^+ and y_j is called inadequate rate of output.

Among the studies on calculating eco-efficiency by using DEA method, the main difference is that the undesirable output regarded as the input indicator or the negative output indicator, which will lead to different DEA models. In this study, we will regard the environmental impact as the inevitable cost to obtain economic value, and therefore undesirable outputs will be considered as the input indicator (Table 1). In the specific indicators design and selection, input indicators are divided into two categories: resource consumption and environmental impact. Based on the availability of the data, resource consumption indicators include industrial electricity, industrial enterprises' energy consumption and industrial enterprises' water consumption; environmental impact indicators include industrial wastewater emission, industrial SO_2 emission and industrial soot emission. Output indicators are used by the total industrial output value of the cities to reflect industrial output.

3 Empirical Analysis

Use either SI (MKS) or CGS as primary units. (SI units are strongly encouraged.) English units may be used as secondary units (in parentheses). This applies to papers in data storage. For example, write "15 Gb/cm^2 (100 Gb/in^2)." An exception

Table 2 Eco-efficiency evaluation result of Beijing-Tianjin-Hebei metropolitan region from 2006 to 2008

City	2006	2007	2008
Beijing	1	1	1
Tianjin	1	1	1
Qinhuangdao	0.3225	0.3706	0.3945
Tangshan	0.2782	0.2797	0.3409
Langfang	1	1	1
Baoding	0.6639	0.7221	0.7475
Shijiazhuang	0.5055	0.4576	0.5695
Cangzhou	1	1	1
Zhangjiakou	0.2120	0.2337	0.2298
Chengde	0.3167	0.3513	0.4380

is when English units are used as identifiers in trade, such as “3.5-in. disk drive.”

According to “China City Statistical Yearbook”, “Beijing Statistical Yearbook”, “Tianjin Statistical Yearbook” and “Hebei Economic Yearbook”, the relative datum of the ten cities in Metropolitan Areas from 2006 to 2008 were selected, and evaluating every city’s eco-efficiency by DEA method. The analysis software is Lingo, and the result is shown in Table 2.

Table 2 shows that, during the period from 2006 to 2008, the eco-efficiency of Beijing, Tianjin, Langfang and Cangzhou is relatively effective, and it is relatively ineffective in Qinhuangdao, Tangshan, Baoding, Shijiazhuang, Zhangjiakou and Chengde. Among them, the value of Zhangjiakou region is the lowest, which the 3-year average is only 0.2252, and the amplitude of fluctuation is low in the 3 years. In fact, statistics show that, in addition to the amount of industrial wastewater discharge from Zhangjiakou slightly less than that from Beijing, the amount of industrial SO_2 emissions and industrial soot emissions from Zhangjiakou area is higher than that from Beijing area, while its total industrial output value is less than one-tenth of Beijing total industrial output. This indicates that its industrial output is still limited to rely on serious ecological overdraft due to economic underdevelopment in this region. According to the vertical comparison to the rest five relatively ineffective cities, although all the cities’ eco-efficiency is invalid, it tends to increase gradually in addition to Shijiazhuang, where its eco-efficiency declined in 2007.

In order to further analyse the deep-rooted reason and clarify their eco-efficiency improvements direction, the study analyzed the input redundancy rate of productivity input factors in these cities in 2008. The results are shown in Table 3.

Respectively, the main problem in Qinghuangdao is that the efficiency of industrial water is relatively low, and the input redundancy rate is highest among ten cities, which is 29.87 %, indicating that there may exist serious waste on industrial water use. On the environmental impact, industrial SO_2 emission and industrial soot emission all have the higher input redundancy rate, and thus the reduction focal point is industrial gas emission abatement in the future.

Table 3 The analysis of eco-efficiency input redundancy rate in 2008 (%)

City	Industrial electricity	Energy consumption	Industrial use of water
Beijing			
Tianjin			
Qinhuangdao			29.87
Tangshan		8.00	23.88
Langfang			
Baoding			
Shijiazhuang		14.01	19.17
Cangzhou			
Zhangjiakou		3.97	
Chengde			16.39
City	**Wastewater discharge**	**SO_2 discharge**	**Soot discharge**
Beijing			
Tianjin			
Qinhuangdao	3.20	22.78	10.74
Tangshan		16.98	20.96
Langfang			
Baoding	50.45	47.62	39.19
Shijiazhuang		30.06	16.80
Cangzhou			
Zhangjiakou		17.72	11.64
Chengde	10.32	30.89	31.03

The main problem in Tangshan is that there exists waste in both industrial enterprises energy consumption and water consumption, which the input redundancy rate are respectively 8 % and 23.88 %. On the environmental impact, the main problem is that the industrial soot emission and industrial SO_2 emission are too high, and thus the future work should focus on the industrial waste gas emission reduction.

There does not exist input redundancy issue on resource consumption in Baoding, but its input redundancy of the environmental impact input factors is serious. The input redundancy rates of industrial wastewater, industrial SO_2 and industrial soot are as high as 50.45 %, 47.62 % and 39.19 % respectively, which are the highest among the ten cities, indicating that it is important to emphasize reducing emission which is the major direction to develop economy and improve ecological efficiency.

Shijiazhuang is similar with Tangshan, and its main problems are higher industrial enterprises' energy consumption and water input redundancy rate. And the industrial SO_2 emission and industrial soot emission are higher as well on environmental impact.

It is not serious on input redundancy problem of resource consumption in Zhangjiakou, and it is just 3.97 % for industrial enterprises energy consumption. The main problems lie in the higher input redundancy rate of industrial SO_2 emission and industrial soot emission, and thus the main point in the future is on the industrial waste gas emission reduction.

The input redundancy rate of industrial water is a bit high in Chengde, indicating there is a certain degree of waste. And the input redundancy rates of its industrial wastewater, industrial SO_2 and industrial soot are lower than that of Baoding, indicating the further work should focus on the industrial waste gas emissions reduction.

4 Conclusion

Since the beginning of this century, some contradictions and problems impacting social and economic development have become increasingly prominent, and rapid consumption of resources and environmental degradation has become the important factors affecting the sustainable, stable and healthy development of society and economy. As the third of China's economic growth pole, the advantage of Beijing-Tianjin-Hebei Metropolitan Region is obvious, and the economic growth rate is significantly higher than that of the national average. But for a long time, due to the limitation of subjective understanding, the symbiotic relationship between the ecological environment and sustainable development is ignored, and ecological issues such as environmental pollution, scarcity of resources etc. is increasingly restricting the development of the region. Such phenomenon is universal in the country, thus the paper will have the important reference value for industrial ecological construction in China. According to the paper, we got the conclusions below.

1. The eco-efficiency of Beijing, Tianjin, Langfang and Cangzhou is relatively effective; and that of Qinhuangdao, Tangshan, Baoding, Shijiazhuang, Zhangjiakou, Chengde is relatively ineffective.
2. For the six cities where eco-efficiency is relatively ineffective, the common problem is that there is a higher input redundancy rate on industrial SO_2 emission and industrial soot emission, suggesting that the reduction of industrial waste gas emission will be the common focus of these cities in the future. In addition, there are still serious industrial water profligacy in Qinhuangdao and Chengde. Energy and water conservation should be strengthened in Tangshan and Shijiazhuang, and it should pay more attention to reduce emission of industrial waste water in Baoding.

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Food Regional Economic Regulation and Control Policy Research

Zhi-qiang Feng

Abstract This paper based on the grain security, the grain the macroeconomic regulation and control of the operation mechanism of the general theory, focus on the China's grain macroeconomic regulation and control mechanism, the concept of grain macroeconomic regulation and control mechanism, the grain circulation macroeconomic regulation and control tool application, grain circulation macroeconomic regulation and control system, the problem of grain circulation system, grain price formation mechanism. Through the research set up grain macroeconomic regulation and control of the operation mechanism of general theory.

Keywords Grain economy • Grain macro-control mechanism • Macroeconomic management

1 Introduction

China's grain macro-control mechanism is: follow the grain economic law, with the national grain security as the foundation, the grain economy structure adjustment as power, based on production and supply balance, trade and consumption balance, price and social grain total cost balance, grain reserves and degree of self sufficiency balance as the key point, establish and perfect the grain security is the core of the production, processing, trade, reserve, consumption for control system, the government on grain market effectively in macroeconomic regulation and control, urbanization and agricultural modernization, industrialization process, improve the grain farmers enthusiasm, protect grain producers and consumers' vital interests,

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early warning and solving the international and domestic grain crisis and risk, maintain grain markets continue to stability and promote national economic security mechanism (Zhiqiang Feng 2002).

Grain macro-control operation mechanism is the regulation of the target, the main body of the control, regulation and control tools and control system composed of four parts. Grain macro-control operation mechanism is the direct subsidy, price support, income security, infrastructure and public service five policy formation.

Grain circulation macroeconomic regulation and control system to regulate the construction of China's grain market order, and improve the efficiency of grain circulation, ensure grain supply, achieve grain security and promote the coordinated development of the economy and society has a very important role. The market mechanism is to promote the efficient allocation of resources mechanism, but the lack of necessary to control the simple market regulation is caused extremely easily grain supply and demand fluctuation and the market is not stable, thus affecting grain security. According to the market economic operation rules and the WTO rules in order to attach importance to the role of market mechanism, and at the same time try to construct the grain macroeconomic regulation and control mechanism, and the effect to the international market competition, to ensure that grain security and social harmony and stability (The State Council 2004).

2 Methodology

Grain problem involves groups of different interests, different interest groups have different goals. China's grain macro-control mechanism basic goal seven levels, seven big goal: the first level of target is grain economic security; The second level is the goal of the grain market; The third level is the goal of grain stability; The fourth level goal is to minimize the government financial burden. The fifth level of objective is to protect the farmer benefit, The sixth level goal is to grain industry development; The seventh level of target is the effective operating of the grain enterprises (The United Nations Grain and Agriculture Organization 2010).

3 Results

3.1 Grain Regulation Mechanism of the General Requirements of Main Body

Regulation mechanism to transcendental subject position, ensure the maximization of total social welfare. Regulation mechanism subject to independent decision-making rights, not affected by checks and balances. Regulation mechanism subject should have authority, according to the grain economic law and grain laws and regulations on work. Regulation mechanism subject to necessary control tools, such as grain risk fund, grain special reserve, price intervention economic tool. Regulation mechanism subject to have a more complete information, the use of grain early warning mechanism collect information (Agriculture 2008).

3.2 The Central Government Macroeconomic Regulation and Control Mechanism of Grain Is the Only Subject

Theoretically, grain as a national public product with special properties of the goods, the control rights and responsibility should belong to the central government, which is the main body of the regulation in the government. The central government on grain for the macroeconomic regulation and control, can play the enthusiasm of the local government (Agriculture 2008).

3.3 Grain Macro-control Mechanism Can't Make "Decentralized"

From the control mechanism of the main requirements and control principle to see, grain control rights must be unified, control rights can only focus on the central government, the central government is the only main body of the decision-making and the regulation of the main body of responsibility for. "Decentralized" because regulation subject interests are not consistent, and offset control effect, can appear even reverse regulation. Grain control can only lead by the state council, the grain experts mainly comprised of grain macro-control committee to perform (China's National Development and Reform Commission 2008).

4 Discussion

4.1 The Grain Safety Stock

Grain reserves are essentially a "minimum grain inventory" concept. The international recognized reserves of grain concept are put forward by FAO, called "carry forward reserve" or "buffer stock". Although the grain supply and demand situation changed, but grain reserves for the present, the control of market tool cannot be changed, but also play a more active role (Zhenbang Nie 2009).

4.2 Grain Import and Export Trade

Grain import and export trade macroeconomic regulation and control is an important tool, is through the grain import and export trade to ensure that the domestic grain market stability and the control of grain price fluctuations, make full use of the advantage of international division of labor.

4.3 Grain Financial Subsidies

Grain subsidy way and direction from the past to the circulation link subsidies subsidies production link, from indirect subsidies direct subsidies to change. Actively use the "yellow box policy", to solve the problems of the protection of the negative.

4.4 Financial Insurance

Financial insurance is incentive farmers grow grain of a kind of indirect control measures, the tools use low cost, less to market intervention, guiding role is stronger. Financial insurance guidance, support and help grain producers (Zhiqiang Feng 2010).

4.5 Other Tools

Some basic support the use of policy plays a control tool. Such as the commodity grain base infrastructure support, major grain producing areas production and operation of the tax concessions, grain production technology support, application technology promotion, major grain producing areas of farmland water source protection, etc. (Henan Provincial People's Government 2011).

5 Conclusion

5.1 The Unified Grain Control Command System

Grain macro-control is a matter of national economic security, the establishment of unified grain macro-control command system, unified leadership and guidance of the grain production and operation activities. Grain regulation is also a regular work, by full-time national grain macro-control committee to implement (The State Council 2011a).

5.2 *Efficient Grain Reserve System*

Grain reserves is the important tool of macroeconomic regulation and control of grain, is to ensure grain safety of the important means. Our country known as the “present storage” fine tradition. In order to improve the grain macro-control system, the central grain reserve “feng regret swallowed up” and the control of grain, basic to achieve the purpose of macroeconomic regulation and control. State grain reserve scale, structure, management mode and reserve system cannot fully adapt to the needs of the national macroeconomic regulation and control of the contradiction. One is, reserve management; The second is, reserve scale; The third is, reserve mechanism; The fourth is, reserves supervision (The State Council 2011b).

5.3 *Agile Grain Import and Export Trade System*

China’s grain import and export mechanism not agile, resulting in the domestic trade and foreign trade disrupted, grain trade to domestic and international market changes do not have enough elastic, we must make a thorough reform. One is, unified grain import and export management mechanism. The second is, the unified organization of the grain import and export trade. The third is, determined the best grain imports, help improve the total social welfare grain economy (The National Development and Reform Commission 2011).

5.4 *Sensitive Grain Early Warning and Emergency Treatment System*

Grain’s macroeconomic regulation and control of timeliness depends on grain forecast and warning of the accuracy and timeliness, grain macro-control effect depends on emergency effectiveness. Grain safety forecast warning and emergency mechanism is to establish grain information system as the foundation, on grain market dynamic monitoring and study the change rule and development trend, when the market supply and demand imbalance, appear a warning signal, take some emergency measures to control the market properly, otherwise the opposite aspects regulation. Establish grain early warning and emergency mechanism must grasp the following several aspects: one is that the composition of the early warning and emergency response mechanism. The second is, warning the emergency treatment mechanism operation procedure. The third is, the management of early warning and emergency response mechanism (Affairs Office of the State Council 2012).

5.5 A Full Range of Grain Support Protection System

Grain to this definition, the inferiority, public welfare and benefits of externalities, determine the grain producers personal yields less than the social rate of return. If there is no external support to improve grain producers personal rate of return, producers will give up grow grain, which endanger grain economic security. Therefore, the new grain circulation system should be grain support protection system construction in the important position. One is, grain direct subsidy system. The second is, the major grain producing areas of infrastructure construction. Three is that grain production technology, grain quality transformation technology support. The fourth is to major grain producing areas and grain producers to provide policy financial support and policy insurance support for grain production to provide the necessary funds, spread the risk of grain production and operation.

5.6 The Grain Circulation System

China's grain circulation system is the main problems: no sound grain circulation law system; Don't improve the grain circulation of administrative management system; Not a sound grain circulation market system, Not a sound grain circulation control system; Not a sound grain circulation service system; Not a sound grain resource allocation system; Not a sound grain comparative income system; Not a sound producing benefit compensation mechanism system; Not a sound grain logistics system (Zhiqiang Feng 2012a).

5.7 Grain Price Formation Mechanism

Under the condition of market economy, the formation of the grain prices to the market as the basis, this is the objective requirement of the rules of market economy, the practice shows that its inevitability (Zhiqiang Feng 2012b).

1. The market regulation grain prices can promote grain production technology progress.
2. Market regulation grain prices, price fluctuates up and down, to regulate the market supply and demand to relative balance of supply and demand.
3. Market regulation grain prices is helpful to guide the production, planting structure adjustment.

4. Market regulation grain prices to guide consumption, avoid the waste of resources.
5. Establish and improve China's grain price belt system.

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An Incentive Model for University Teachers Based on Knowledge

Li-shuan Qin

Abstract Institutions of Higher Learning are typical knowledge-focused organizations. How to motivate the teaching faculty is one of the core contents of modern university system. In this paper, the features of university teaching staff are explored from the perspective of knowledge, and based on this an incentive model has been constructed. As for the content and structure, three parts are involved. Firstly, the concepts and distinctions involved in university teaching faculty are presented and analyzed. Secondly, through case studies, the incentive factors playing key roles in motivating teachers are explored. Most importantly, an incentive model based on knowledge has been creatively attempted and constructed.

Keywords Factor analysis • Incentive model • Incentive system • Perspective of knowledge • University teachers

Institutions of Higher Learning are typical knowledge-focused organizations in which teaching resources are very important knowledge assets. How to motivate the teaching faculty is one of the core contents of modern university system. In the era of knowledge economy, in order to cut an edge in the increasingly competitive environment, universities are adopting different measures in recruiting, training and retaining the required talents.

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1 University Teachers from the Perspective of Knowledge

In the era of knowledge economy, universities not only transfer and diffuse inherent knowledge, but also cultivate innovative talents for society, and directly serving community through fruits of scientific research by teachers and students.

University teachers are knowledge-based employees of the university organization specializing in teaching, research, social service, management and other academic work. Teachers and students, who are the primary resource in knowledge economy, jointly form the main body of colleges and universities. In other words, it is the university teachers and students who share the main responsibility of serving the public (Tingcao Zhou 2007).

University teachers specially engage in knowledge work. As knowledge workers, they have the following five characteristics:

1. As is known to all, the professional level of university teachers is the determining factor for quality teaching. In recent years in China, the current trend of teaching staff getting doctoral degree appears irresistible. However, to them the initial investment cost is huge. Estimated in accordance with our current economic level of consumption, 240,000 yuan is required to get a master's degree and 360,000 yuan for a doctorate (Bajun Fu 2009). Therefore, the high remuneration expectation of university teachers is not unexpected.
2. Research work is the signified and dominant element for university teachers. In 1810, the principle of "teaching and research unity" was presented by the University of Berlin in Germany, imposing a revolutionary impact on higher education worldwide. Henceforth, it has grown to be the second largest function of colleges and universities (Wenzi Ye 2006). First of all, research capacity and scientific fruits can actively contribute to teaching. Teaching activities based on knowledge dissemination and diffusion are forms of academic activities highly involved in creative efforts of both sides. With high academic proficiency, a more thorough understanding of knowledge can be achieved, thus shortening the distance between the receivers and the teachers more effectively. In addition, academic research has become a relatively independent function of universities. As the "engine" of knowledge economy, it also plays a vital role in promoting social progress and development (Buunk and Carmona 2011).
3. Teaching and guiding are the two basic responsibilities of university teachers. Classrooms are the usual places for teaching activities, through which teachers try to lead students to their professional field, and trigger their desire for more knowledge. After class teachers are also expected to give appropriate assistance to students, especially give guidance on their research papers (Hearn 2001).
4. Serving the community. At the beginning of the twentieth century, Hayes, the president of the University of Wisconsin, appealed that the teaching and research activities of universities should take social needs into consideration. Thereafter, "social service" has grown to become the third important function of universities (Varghese 2004). Apparently, these responsibilities are assumed to be taken

by university teachers, to be specific, through their research project (Velu and Nordin 2011).

5. Being creative and free. Innovation is a fundamental property of the academic work, the important foundation of the university itself, and also the necessary condition for academic development. Through identification and integration of effective knowledge, university teachers work with complexity and creativity. With the high-risk and unpredictable nature, the smooth progress of knowledge work needs a free academic environment (Klinker and Agnello 2010).

2 An Empirical Analysis of Teacher Incentive Management

Incentive management process is very complicated, which emphasizes not only the strengthening process, but also the integrated dynamic system as a whole. To get a clear picture of the career incentive situation of university teachers in China, an empirical analysis is presented here as follows.

2.1 Questionnaire Design and Sample Selection

2.1.1 Questionnaire Design

By the survey of questionnaire, an empirical analysis is to be done to the current situation of teacher incentive in China. Questions are designed mainly with close options, scoring from 1 to 9. The main variables include the following:

For Q1 the occupational attractive factors, the alternative options are: Q11 remuneration, Q12 insurance and welfare, Q13 stability, Q14 personal career development, Q15 working environment and conditions, Q16 working content, Q17 working time, Q18 social status, and Q19 other factors.

For Q2 factors of active working, the alternative options are: Q21 performance appraisal system, Q22 remuneration, Q23 insurance and benefits, Q24 personal career development, Q25 work environment and conditions, Q26 social status, and Q27 other factors.

For Q3 occupational characteristics, the alternative options are: Q31 income competitiveness in the human resources market, Q32 fair remuneration within university, Q33 insurance level and condition, Q34 welfare and benefits, Q35 employee relations within the organization, Q36 work environment and working conditions, Q37 work intensity and pressure, Q38 tasks and challenges, Q39 self promotion through work, Q310 job promotion and opportunities.

As for the academic outcomes, three perspectives are involved: teaching, research and social services. Four aspects are examined concerning the performances of teaching evaluation/self-assessment, published papers, published books and research funding (Stembridge 1989).

2.1.2 Sample Selection

In this study, university teachers in Beijing are selected randomly for survey. To obtain first-hand information, three ways of investigation are involved: questionnaire, telephone consultation and interview.

In this survey, 300 questionnaires are distributed, 277 copies are collected. After preliminary sorting, 270 questionnaires are valid, the validity rate being 90 %.

In this study, to test the questionnaire reliability, internal consistency reliability Cronbach α is calculated, $\alpha = \left(\frac{k}{k-1}\right)\left(1 - \frac{\sum S_i^2}{S^2}\right) = 0.605$. Here, $S^2 = \mathrm{Var}(\sum X_i), S_i^2 = \mathrm{Var}(X_i)$. Hence, the results can be trusted.

2.2 *Statistical Analysis Description*

2.2.1 Career Attraction Factors

Statistical analysis report shows that the career appealing factors of being university teachers were listed from strong to weak as follows: Q13 stability, Q14 personal career development, Q17 work time, Q16 job content, Q11 remuneration, Q15 working environment and conditions, Q18 social status, Q12 insurance and welfare, and Q19 other factors.

2.2.2 Influential Factors for Active Work

The influential factors for active work are successively listed as follows: Q21 performance appraisal system, Q24 personal career development, Q22 remuneration, Q26 social status, Q23 insurance and welfare, Q25 working environment and conditions, Q27 other factors.

2.2.3 Professional Feature Index of University Teachers

University teachers in Beijing generally agree that Q31 the external competitiveness of pay levels is not enough; Q32 the internal fairness of remuneration is also relatively weak; Q35 the employee relationship within organization is not ideal. Respondents generally feel that Q37 the intensity and pressure of work are strong; Q38 the tasks are challenging. However, Q33 the insurance level and condition, Q34 the welfare and benefits are comparatively satisfactory; Q36 the work environment and working conditions are ideal; Q39 their abilities can be improved; Q310 work has job promotion opportunities.

2.3 Output Factor Analysis

As for the work output, based on the factor analysis of professional characteristics of university teachers, report shows:

1. Based on the ten indicators of occupational characteristics that affect academic output, common factor is extracted by principal component method: KMO = 0.598, Sig = 0.000, thus the consistency test is passed. The ten indicators include: Q31 the external competitiveness of pay levels, Q32 the internal fairness of remuneration, Q33 the insurance level and condition, Q34 the welfare and benefits, Q35 the employee relationship within organization, Q36 the work environment and working conditions, Q37 the intensity and pressure of work, Q38 task challenge, Q39 self improvement through work; Q310 job promotion opportunities.
2. In this study, four common factors are extracted by the principal component method, which can explain 49.99 % of the overall variance. In other words, the explanation is effective.
3. The four common factors

   The first common factor F1 includes the following indicators: Q33 the insurance level and condition, Q34 the welfare and benefits, Q35 the employee relationship within organization, Q37 the intensity and pressure of work.

   The second common factor F2 involves: Q31 the external competitiveness of pay levels, Q33 the insurance level and condition, Q34 the welfare and benefits, Q39 self improvement through work.

   The third common factor F3 contains: Q37 the intensity and pressure of work, Q38 task challenge.

   The fourth common factor F4 mainly includes: Q310 job promotion opportunities, Q35 the employee relationship within organization.

   The contribution rate of each indicator, see Table 1.

3 An Incentive Model for University Teachers from the Perspective of Knowledge

Based on theory of motivation and conclusions of the above empirical analysis, an incentive model is attempted (see Fig. 1).

Table 1 Ingredient matrix

	Ingredient			
	1	2	3	4
Q31	.616	−.436	−.033	.072
Q32	−.261	−.159	−.020	.661
Q33	.590	−.313	.036	−.040
Q34	.500	−.113	.323	−.148
Q35	−.276	−.072	.452	−.532
Q36	−.225	−.316	.223	.296
Q37	.102	.605	−.216	−.145
Q38	.251	.565	.140	.295
Q39	.657	.275	.027	.141
Q310	−.029	.222	.802	.203

Note: The extraction method – the main ingredient; the four extracted ingredients

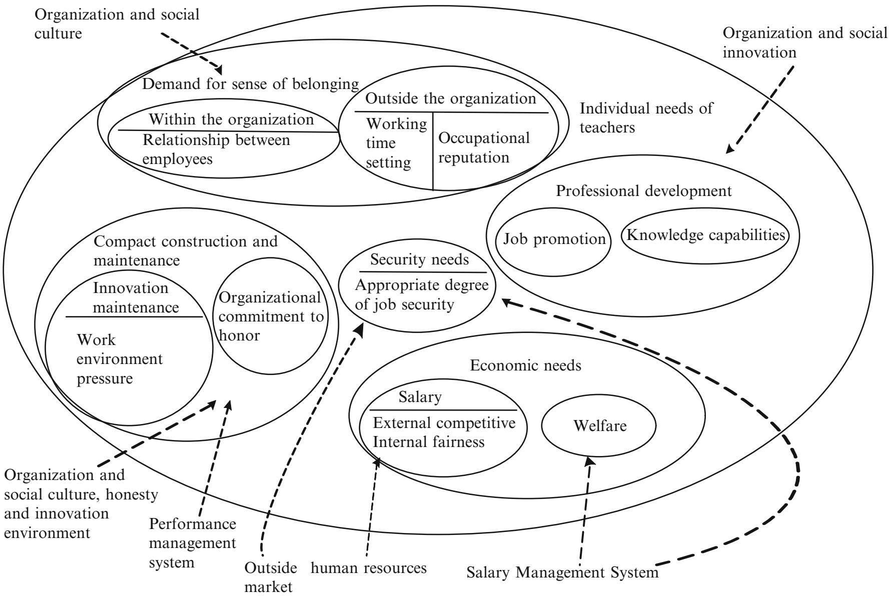

Fig. 1 Incentive model for university teachers

3.1 Model Structure

Teacher's work behavior is closely related to their various personal needs, university organization, work contract, psychological contract and so on. Teacher's job satisfaction is subject to compensation management system, performance management system, job setting, organizational innovation, organizational culture, etc. (Davis and Wilson 2000). Moreover, teacher's job satisfaction and attitudes to work are also influenced by the innovation and the development of the outside social environment (Menges 1997).

In this incentive model, the basic needs of university teachers include:

1. The needs of personal career development. Personal career development is the most important need of university teachers. Given opportunities for job promotion and progress in knowledge and capabilities, university teachers can work out their potential and chase their dreams. In addition, their personal career development is also determined by the organizations and social environment for innovation and development (Menges 1997).
2. Constructing and maintaining contract. The work of university teachers is based on the physical contract and psychological contract between the teachers and their universities, bound and guided by the contractual relationship between people and organizations. The incentive role of contract is achieved by teacher's commitment to his or her organization as well as the maintenance of knowledge innovation. Maintenance to innovation and knowledge work is reflected in the following aspects: challenging work for university teachers, moderate work intensity and pressure, innovative working environment and good working conditions. Universities also work out proper performance management systems, and cultivate honest, innovative organizational culture to ensure the consistency of innovative work of teachers. In fact, the construction and maintenance of the contract between universities and their teachers is also influenced by social innovation, development and culture of integrity (Sveiby and Lloyd 1987).
3. Demand for sense of belonging. University teachers, either working or living, are in social network and need certain sense of belonging. On one hand, university teachers need good employee relations within the organization; on the other hand, outside the organization, whether it is in the family, or in wider professional circle, in other social interactions, well-maintained family and social relationships are their great expectations (Drucker 1988). Therefore, university organizations should provide their teachers with conditions for maintaining such social relations, including good relations of organization staff, reasonable working hours, holiday arrangements, and professional reputation, etc.
4. Demand for security. Generally speaking, occupational insurances for university teachers are important ways to meet their security needs. As effective measures, a variety of insurance funds are provided such as pension insurance, medical insurance, unemployment insurance, maternity insurance, injury insurance and so on. With the accelerated social change and unsteady market, teachers' demand for career stability is increasingly felt. The high level expert knowledge needs long time to accumulate. In addition, knowledge innovation also involves a high degree of risk and an unpredictable nature, which has intensified the demand for teachers to care about their job stability. The degree of satisfaction in this aspect is connected with the salary management system as well as the conditions of outside human resource market (Skinner 1938).
5. Economic needs. Economic need is the basic need in economic society, which is also a premise for other needs. The creative work of university teachers requires a certain amount of economic compensation for their labor and cost as encouragement. Keeping pay levels with external competitiveness can attract

and retain brilliant teachers. Keeping fairness in internal remuneration can meet their psychological needs. Keeping an attractive welfare system can effectively compensate for their creative work and help to work out their potential.

3.2 Feature Analysis of the System

The model system is a dynamic, open and organic system.

1. The incentive model system is an open system, in which the components are inevitably influenced by factors outside the system. Firstly, social innovation, development and culture have impact on higher educational institutes and university teachers. Changes of human resource market are also related to the pay levels, stability and working pressure of the teachers. Moreover, the strategic development, the rules and regulations, and the innovation culture all have a direct or indirect impact on motivation of teachers as well.
2. The internal structure of the system carries at three levels. The most peripheral of the system includes social innovation, development, culture and other factors. On the organizational level, the incentive measures involve such aspects as organization strategy, salary management, performance management, innovation, development and other organizational culture, which are the important components of incentive system. On the individual level, according to the professional characteristics and the conclusions of empirical analysis, their needs are divided into the following five aspects: personal career development, contract construction and maintenance, sense of belongings, security needs, and economic needs.

The incentive model is a dynamic organic system with varying degrees of interaction between elements. The five major subsystems depend on each other and support each other. In the era of knowledge economy, with rapid development of knowledge innovation and social change, the changes in any factor may bring about influence to the entire system and may produce a “butterfly effect”. In fact, all factors of the system exist in a dynamic development process during which a dynamic and orderly balance is achieved and maintained.

4 The Incentive System of University Teachers Based on the Perspective of Knowledge

4.1 The Purposes and Principles of the System

1. Design Purpose: Since the direct purpose is to motivate the work of the teachers, the starting point and destination should meet the diverse needs of teachers. While the primary purpose is to achieve the strategic objectives of university development, therefore how to promote the optimal allocation of

human resources is the main consideration to achieve the goals of university development.

2. Design principles: scientific and systematic. Try to keep the balance of both fairness and efficiency, both timeliness and appropriateness, both differences and competition, both humanity and institutionalization (Yongming Wang 2008).

4.2 The Construction of Incentive System Based on the Perspective of Knowledge

4.2.1 The Establishment of Scientific Management System and Incentive System of Distribution

1. Evaluate the quality and quantity of teachers' knowledge work. The evaluation is expected to be measured against the education goals of the school and the tasks assigned. By evaluation feedback, further motivate and improve the behavior of teachers, thus mobilizing their work enthusiasm and creativity.
2. Raising salary, bonuses, benefits, welfare, funding and others are the major material incentive ways to build an effective incentive-supporting system.
3. The organizational culture environment consists of theories, values, rules and regulations that have an impact on its members. Organizational culture can actually guide, regulate and motivate the knowledge behavior of university teachers.

4.2.2 The Construction of a Guiding-Oriented Incentive System

1. Target incentive. The purpose of arousing teachers' enthusiasm, initiative and creativity could be achieved by converging the goals of both individual teachers and the university.
2. Career development incentive. Giving full consideration to teachers' expectations is essential. If appropriate opportunities and timely help in various stages of growth are provided, then teachers' potential can be brought up.
3. Training incentive. Training is a means of career management. Enhancing teacher's own consciousness of self-motivation is also one of the important ways to modify their values, attitudes and behavior, thus improving their teaching ability.

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The Private Listed Company Executive Compensation and Company Performance: Based on Moderation Effect of Stock Rights

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Abstract This paper is study on executive compensation and company performance in Chinese private listed company. We use panel data multiple regression to analysis the data, which is from 2006 to 2010. The results indicate the number of man getting salaries in board of directors and board of supervisors is uncorrelated to company performance. Compensation of board of directors is positive correlation to revenue, net income and total assets. Compensation of executive is negative correlation to operation revenue and total assets, but is not significant to net income. In addition, the relationship between executive compensation and performance is non-liner. Further this study found that voting right of controlling stockholder and the quantity of CEO's stocks had moderation effect to the compensation and performance.

Keywords Executive compensation • Moderation effect • Non-linear relation • Private company

1 Introduction

All listed companies have to confront the problem of principal-agent, include Chinese private companies. With China's economic development, in capital market, Chinese listed private companies increased. The diversity of ownership structure prompted the measures of incentive and constraint agent. But the equity relative concentration is still outstanding feature of Chinese listed private companies.

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In these companies, what is the effect of the salary incentive. Generally, the salary incentive of senior executives is effective to company performance. Is there any other person whose salary incentive is effect to the company performance? Which are the moderators of the relationship between salary and performance? That is a valuable problem to research.

2 Review of Related Literature

In theoretical research, Jensen and Meckling's (1976) classical research, about the agency problem is the most cited literature. They think agency cost is in everywhere. The agent will deviate from the principal's interest. In order to control the agent, the principal have to properly incentives the agent, and undertake the monitoring cost caused by it. They conclude giving managers stock rights and payment will contribute to reduce the managers' opportunism which including company-paid consumption, robbing shareholder wealth. For solving the agent problem, the direct effect is giving senior executive salary and stock incentive has long effect.

In the Empirical research, the topics on payment, stock rights and corporate performance are emphasis of corporate governance. Most of the researches are focus on senior executive (especially CEO) and they consider that it is positive correlation between CEO's salary and company performance (Bin Liu et al. 2003; Murphy 1985; Jackson et al. 2008). Jensen and Murphy (1990) have already research the payment form on the sensitivity of the performance, which include cash payment, the internal shareholding etc. They find it is positive correlation between salary and performance, but the function is limited of the incentive.

In view of the American company samples, Morck et al. (1988) find it is inverse U type between managerial ownership and corporate value. When manager have low quantity of holding stock, stock incentive mechanism is effective to increase the value of company. When manager have high quantity of holding stock, manager can more optional to draw water to one's own mill and is harmful to the company value. With empirical study, Claessens et al. (2000) find that the value of listed company increase along with cash flow rights owned by the largest shareholder. Certainly, part of post research finds it is not correlation between payment and performance (Hirschey and Pappas 1981; Carroll and Ciscel 1982; Sigler and Haley 1995; Junxiong Fang 2009).

In China, early studies do not find it is not notable correlation between senior executive payment and company performance. With the development of Chinese company, the markets are more mature. Xingqiang Du and Wang Lihua (2007), Xiangyi Xu et al. (2007) found that it is notable correlation between senior executive payment and company performance. The further study find there is viscidity characteristics of executive compensation performance sensibility. When the performance increased, the range of the increasing payment is notable more than the range of performance decreased. Honglin Yu (2006) considered that, in China, the level of listed company managers is positive correlation to the company value, but it is not notable. There is few study on private company about this topics, scholars often look private company as complement of stated owned company. There is still less study about private listed company's stock, payment and performance. We do not seek any paper about the moderator of relationship between payment and performance in private listed company.

3 Hypothesis and Sample Selection

In this research, payment is defined as monetary compensation. Due to data availability, this research did not consider the effect of non-monetary compensation. Company performance include: operating revenue, net income, total assets, basic EPS (earnings per share). Senior managers include: chairman of the board, CEO etc. managers, director and supervisory of the board. All of the data is from CCER data base. This paper use STATA soft to analysis and test the theory. The range of the data is from 2006 to 2010 and the data is not balance panel data, we transform the data into balance panel data. The result is that there are 403 companies and 2,015 records according to research need. We select 14 variables including dependent variables, independent variable and control variables. The summery of the 14 variables can be read in Table 1.

According to research need, we divide all variables into four kinds, which including dependent variable, independent variable, control variables and moderator variable. L11, L12, L13, L14 are dependents; L2, L3, L5 are control variable; L4, L6, L9, L10 are independent variables; L1, L8, L7 are alternative moderators. According to the related theory, we make the following hypothesis:

H1: senior executive compensation is correlation to the listed private company performance.

- H1a: the number of senior executives receiving compensation is positive correlated to company performance
- H1b: senior executives compensation is non-liner correlated to company performance.

H2: the stock right is the moderator of the relationship between senior executives payment and company performance.

- H2a: the stock right of control stock holder moderate to the relationship between senior executives payment and company performance.
- H2b: the quantity of CEO stock holding moderate to the relationship between senior executives' payment and company performance.

Table 1 Variables summer

Var	Mean	Std. dev.	Min	Max
L1	32.77575	14.89805	2.06	87.85
L2	5.688834	1.570884	0	19
L3	3.336973	0.9241856	0	10
L4	3.940943	1.916838	0	12
L5	3.653598	1.120853	0	11
L6	2.637221	1.256129	0	8
L7	0.0307897	0.0990799	0	2.71
L8	3,550,256	2.90E+07	0	1.12E+09
L9	804,840	1,036,967	0	1.54E+07
L10	764,743.4	1,197,376	0	4.33E+07
L11	1.85E+09	4.53E+09	0.0001	7.55E+10
L12	1.13E+08	3.23E+08	−2.81E+09	5.62E+09
L13	2.57E+09	3.98E+09	222,849.1	4.83E+10
L14	−0.2705816	22.2714	0	5.8932

Notes:
L1: the right to vote of control stockholder
L2: the board of directors scale
L3: the numbers of independent directors
L4: the numbers of directors receiving payment
L5: supervisor scale of board
L6: the numbers of supervisors receiving payment
L7: the stockholder ratio of chairman of the board
L8: the quantity of stock holding of CEO
L9: the payment sum of the three directors whose payment is top
L10: the payment sum of the three managers whose payment is top
L11: operating revenue
L12: net income
L13: total assets
L14: basic EPS (earnings per share)

4 Results

We choose panel data multiple linear regressions (MLR) to analysis the data. The results are below:

We use L11, L12, L13, and L14 as independent variables and separately from four models: M1, M2, M3, M4. Firstly, we distinguish the four models with fixed effect or random effect, though Hausman Test, if P value of Hausman Test is notable, we strongly refuse null hypothesis, adopt fixed effect model, abandon random effect. The test results of four models are M1, M3, M4 is random, and M2 is fixed effect (Table 2).

Table 2 Linear relationship validation

Var	M1	M2	M3	M4
FE/RE	RE	FE	RE	RE
L2	2.76E+07	1,289,571	−8,300,122	4.74E−01
	−0.634	−0.849	−0.887	−0.295
L3	2.75E+07	6,681,640	2.86E+07	4.13E−01
	−0.689	−0.396	−0.682	−0.507
L5	3.09E+07	9,009,872	4.86E+07	−3.38E−01
	−0.738	−0.418	−0.594	−0.576
L4	−3.86E+07	953,232.7	2.37E+07	6.60E−04
	−0.477	−0.882	−0.661	−0.999
L6	−3.62E+07	−749,068.7	5.46E+07	5.84E−01
	−0.649	−0.936	−0.494	−0.327
L9	705.4978	56.78413	1,317.873	2.17E−07
	(0.000)**	(0.000)**	(0.000)**	−0.762
L10	−147.5612	−7.270933	−332.1699	2.70E−08
	(0.022)**	−0.324	(0.000)**	−0.964
Cons	1.28E+09	8,629,047	1.30E+09	−4.85E+00
	(0.001)**	−0.821	(0.000)**	(0.043)**
R^2	0.1316	0.1908	0.2392	0.0029
F test P value	–	5.14	–	–
		0		
Wald chi^2	77.31	–	255.96	5.89
Hausman P	0.3741	–	0.3123	0.8048

Notes:
1. "*", "**" respectively 10 % and 10 % significant level
2. *FE* and *RE* respectively stand for fixed effect and random effect

4.1 Monetary Compensation Incentive and Performance

Though the results (Table 2), we find: first, earnings per share model (M4), no variables is notable, so we do not consider it in next analysis. Second, L9 (the payment sum of the three directors whose payment is top) is notable positive correlation in M1, M2, M3. L10 (the payment sum of the three managers whose payment is top) is negative correlation correlative in M1, M2, M3, and is not notable in M2, this is inconformity with null hypothesis (H1b). Third, the correlation coefficient of L4, L6 are not notable in M1, M2, M3, M4, this is inconformity with null hypothesis (H1a).

4.2 Test Non-Linear Relationship

In order to test non-linear relationship, we select L11, L12, L13 as dependent variables, respectively regress to payment variables square. Though observing the

Table 3 Nonlinear relationship validation

Var	L13	L12	L11
FE/RE	RE	RE	RE
L2	10,700,000	6,495,628	17,700,000
	0.824	0.188	0.712
L3	1.69E+07	6.20E+06	2.10E+07
	0.808	0.4	0.757
L5	8.02E+07	4.98E+06	1.28E+07
	0.294	0.499	0.870
$(L9)^2$	3.24E−05	8.43E−07	2.46E−05
	0.036**	0.606	0.106
$(L10)^2$	−2.13E−05	−1.08E−06	−1.79E−05
	0.000**	0.013**	0.000**
L9	643.2213	77.11909	136.059
	0.001**	0.000**	0.496
L10	570.1783	25.25392	623.6721
	0.002**	0.182	0.001**
Cons	1.2E+09	−4.3E+07	1.04+09
	0.001**	0.203	0.005**
R^2	0.2396	0.2007	0.1219
F test P value	–	–	–
Wald chi^2	288.99	190.63	98.75
Hausman P value	0.0617	0.5692	0.1207

Notes:
1. "*", "**" respectively 10 % and 5 % significant level
2. *FE* and *RE* respectively stand for fixed effect and random effect

coefficient and significance, we can judge that is U type or adverse U type. In the same method, we judge the FE or RE. The results are in the Table 3. In M5 (L13), the coefficient of L10 square is notable negative, the coefficient of L9 square is notable positive, other independent variables coefficient is also notable. So it is adverse U type relationship between L10 and L13. It is U type relationship between L9 and L13. The model of L11, it is adverse U type relationship between L10 and L11, L9 is not notable. In model L12, it is adverse U type between L10 and dependents.

4.3 Test Moderate Effect

We need to deal the continuous variables with centralization, using the value of variables to subtract the mean (Aiken and West 1991; Smith and Watts 1992; Jensen 1998). In this method, we can decrease the multicollinearity between independents. Then making product term, put the independents, dependents, control variable and product term without centralization into the models. Though testing if the coefficient is notable, we can judge whether the moderate is notable.

Table 4 L1 moderate effect (L13)

L13			
Var	M1	M2	M3
L2	−3.93E+07 (−0.436)	5,328,655 (−0.912)	4,820,131 (−0.920)
L3	8.54E+07 (−0.235)	3.65E+07 (−0.599)	3.52E+07 (−0.610)
L5	6.19E+07 (−0.447)	9.23E+07 (−0.227)	8.35E+07 (−0.272)
L9	–	1,339.543 (0.000)**	1,556.361 (0.000)**
L10	–	−342.5909 (0.000)**	−679.6084 (0.000)**
L1	–	3.09E+07 (0.000)**	3.26E+07 (0.000)**
L1*L9	–	–	−18.03752 (0.005)**
L1*L10	–	–	38.1739 (0.000)**
Model R^2	0.0014	0.2624	0.2905
ΔR^2	0.0014	0.261**	0.0281**

Note: "*", "**" respectively 10 % and 5 % significant level

We select L12 and L13 as dependent variables and L1, L8 as moderators. Test procedure: first, put control variables into the model; second, put independents variables and moderate variables into the model; finally, put product term into the model.

The results in Tables 4 and 5 shows that as dependent variables are L13 (total assets) and L12 (net income), L1 (the right to vote of control stockholder) variable's product term are notable at 5 % significant level, and ΔR^2 are also notable. That means in model (L13) and model (L12), L1 is the moderator, which moderate the relationship between independents L9, L10 to L12, L13. This is according to H2a.

The results in Table 6 shows that as dependent variable is L13 (total assets), L8 (the quantity of stock holding of CEO) variable's product term are notable at 5 % significant level, and ΔR^2 are also notable. That means in model (L13, Table 6), L8 is the moderator, which moderate the relationship between independents L9, L10 to L13. This is fit H2b.

But in Table 7, we find that as L12 is dependent variable, L8's moderator effect is not notable, both p value and ΔR^2. That means L8 is not the moderator of the relationship between L12 and L9, L10.

Table 5 L1 moderate effect (L12)

L12			
Var	M1	M2	M3
L2	4,034,716	6,450,057	6,797,859
	(−0.431)	(−0.190)	(−0.166)
L3	1.23E+07	7,157,663	6,021,266
	(−0.100)	(−0.331)	(−0.414)
L5	3,808,145	6,048,238	6,300,943
	(−0.630)	(−0.410)	(−0.390)
L9	–	107.131	120.1149
		(0.000)**	(0.000)**
L10	–	−22.60258	−36.55971
		(0.001)**	(0.000)**
L1	–	2,098,750	2,118,224
		(0.000)**	(0.000)**
L1*L9	–	–	−2.003319
			(0.003)**
L1*L10	–	–	1.76907
			(0.039)**
Model R^2	0.0095	0.2192	0.2491
ΔR^2	0.0095	0.2097**	0.0301**

Note: "*", "**" respectively 10 % and 10 % significant level

Table 6 L8 moderate effect (L13)

L13			
Var	M1	M2	M3
L2	−3.93E+07	−5,242,535	−811,289
	(0.436)	(0.913)	(0.987)
L3	8.54E+07	3.45E+07	3.81E+07
	(0.235)	(0.620)	(0.584)
L5	6.19E+07	8.06E+07	7.79E+07
	(0.447)	(0.293)	(0.309)
L9	–	1,304.524	1,286.87
		(0.000)**	(0.000)**
L10	–	−3.29E+02	−351.046
		(0.000)**	(0.000)**
L8	–	6.17E+00	6.904564
		(0.000)**	(0.004)**
L8*L9	–	–	−1.5E−05
			(0.003)**
L8*L10	–	–	1.61E−05
			(0.017)**
Model R^2	0.0014	0.2378	0.2660
ΔR^2	0.0014	0.2364**	−0.0272**

Note: "*", "**" respectively 10 % and 50 % significant level

Table 7 L8 moderate effect (L12)

L13			
Var	M1	M2	M3
L2	4.03E+06 (0.431)	5,632,053 (0.254)	6,289,202 (0.201)
L3	1.23E+07 (0.100)	7,036,567 (0.340)	7,323,006 (0.319)
L5	3,808,145 (0.630)	5.27E+06 (0.476)	4,837,949 (0.510)
L9		1.05E+02 (0.000)**	103.9952 (0.000)**
L10	–	−21.53335 (0.002)**	−27.2724 (0.000)**
L8	–	4.64E−01 (0.015)**	0.7570059 (0.004)**
L8*L9	–	–	−2.50E−06 (0.000)**
L8*L10	–	–	3.21E−06 (0.000)**
Model R^2	0.0095	0.1998	0.2071
ΔR^2	0.0095	0.1903	0.0073

Note: "*", "**" respectively 10 % and 5 % significant level

Table 8 L1and L8 regress result in groups

L12			L13		
Var	M−	M+	Var	M−	M+
L1 add or reduce a standard deviation					
L9	90.64132	37.99623	L9	337.1974	822.1218
L10	115.583	78.42284	L10	277.14	1,120.061
Con	−3,863,030	−4.16E+07	Con	2.28E+09	−1.08E+09
L8 add or reduce a standard deviation					
L9	103.8038	65.80106	L9	1,318.549	59.09047
L10	−17.84699	−7.978027	L10	−310.6143	781.0219
Con	−2.13E+07	2.40E+08	Con	1.43E+09	2.76E+09

4.4 Direct Show Moderate Effect

In order to direct show the moderate effect, we adopt regress with groups. As dependents are L12, L13, control variables is the same with above model, independents are L9, L10. The criterion of divide the moderators into groups is using its mean add or reduce a standard deviation. Then we compare with the coefficients, to test the moderate effect. The results are in Table 8, it shows that moderate effect is notable.

5 Conclusion

Among private company senior managers, it is uncorrelated relationship between numbers of the board and supervisor. Payments incentive of the board is correlate to the operation revenue, net income, total assets. But payments incentive of the seniors is negative correlated to the operation revenue, net income, total assets and it is not notable to net income.

Exclusive of the variable the quantity of stock holding of CEO, that is not the moderator to net income, variables which are the right to vote of control stockholder and the quantity of stock holding of CEO are moderators to total asset and net income.

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Study on Cumulative Effect of R&D Investment Performance of Chinese Listed Companies – Empirical Analysis Based on Modified Cobb-Douglas Production Function

Xin-gang Zhao

Abstract These This paper selects 455 manufacturing firms in Shanghai and Shenzhen Stock Exchanges from 2007 to 2011 as study object, establishes a modified Cobb-Douglas production function, and empirically tests the cumulative effect of R&D investment performance using OLS regression analysis. The result suggests that there exists a significant cumulative effect in enterprise's R&D investment performance. From 2007 to 2010, R&D investment has a significant promotion effect on enterprise performance, and the cumulative effect is the largest in the forth year; however, the promotion effect is not significant in 2011.

Keywords Cumulative effect • Enterprise performance • Modified C-D production function • R&D investment

1 Introduction

Scientific and technological research and development has always playing a prominent role in economic growth. In recent years, funding for R&D investment in China has continued to maintain the growth trend, but the performance of R&D investment is far lower than developed countries in the West. The source of sustained economic growth was attributed to the R&D activities by many economists that are organized knowledge creation, production, and diffusion and application process (Wang 2007). If enterprises want to enhance the capability of independent innovation, it is necessary to carry out a large number of R&D investments. There has been extensive literature on the R&D investment for corporate performance impact, Brown and

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of Petersen, Czarnitzki and Hottenrott found that R&D investment has a positive role in promoting corporate performance (Brown and Petersen 2011; Czarnitzki and Hottenrott 2011).

This paper wants to do a deep study around the cumulative effect of R&D inputs performance, explore its inner mechanism and fill gaps in the field. China is in a transition period; to study any questions about our businesses need to consider our special institutional environment background. In a transition period, it's necessary to consider our special institutional environment background when study any questions about our businesses.

2 Review of Literature

Earlier studies of R&D investment' influence on corporate performance that carried out abroad achieved fruitful results. Young and Byrne confirmed that research investment played a significant role in promoting future value of the company (Young and Byrne 2000). Gamer et al. found that R&D investment will have an important impact on the enterprise value (Gamer et al. 2002). Subsequent research of Brown and Petersen also found that R&D investment exerts a huge and positive influence on enterprise value (Brown and Petersen 2011). Markides put forward the "Accelerated traps", namely long-term accelerating R&D investment may bring enterprise highcost risks and unpredictable consequences (Markides 1999). However, Li believed that R&D investment can reduce risks of technology-intensive enterprises and enhance the yield of corporate stocks (Li 2011).

At this stage, the cumulative effect on corporate R&D investment performance is relatively rare; the research results achieved are not rich. Li and Zhou using the high-tech industry as the research object, by the system GMM method to test the relationship between corporate R&D investment and enterprise performance. They found that the impact of corporate investment in research on corporate performance exist cumulative effect, but the text has not elaborated (Li and Zhou 2012).

Zhu and Xu found that R&D investment on firm performance to promote the role of the regression coefficients in the year was increased gradually after 3 years. The results show that the performance of the R&D enterprise not only with a lag of influence, and also has a cumulative effect (Zhu and Xu 2007). Wang and Guo listed in our information and manufacturing data for the study sample, respectively. This can effectively show that there's a cumulative effect on the performance of Chinese listed Companies' R&D investment, that is, enterprise's current R&D investment has a very important positive effect on the enterprise's subsequent performance. Continuous enterprise's investment on R&D will ensure a lasting economic benefit to the enterprise (Wang and Guo 2008)·

Based on the corporate life cycle theory, Liang et al. used 99 machinery, equipment, instruments and electronics companies listed in Shenzhen Stock Exchange from 2007 to 2009 as the research object, using OLS regression analysis to empirically test the relationship between enterprise R&D investment and performance. The results show that: during the growth stage, there's a significant long-term cumulative effect on the investment performance. Also, there's a significant short-term cumulative effect on R&D investment performance during maturity stage. And, during the recession period, the cumulative effect of R&D investment performance is not significant (Liang et al. 2010).

This paper performance an in-depth study on the cumulative effect of investment performance, explores its inner mechanism, hoping to fill the gap in this field. As China is in a transitional period, studying any issues related to local enterprises needs to take into consideration local special institutional environment background. When domestic and foreign scholars study Chinese enterprises, both use Cobb-Douglas production function, but don't take into account the degree of marketization factor in the country, thus the representativeness of the conclusions is debatable. This paper intends to take into consideration the degree of marketization factor to expand into Cobb-Douglas production function, hoping to inspire subsequent research works.

3 Study Design

3.1 Sample and Data

In order to avoid the differences between the old and new accounting standards bring bias to our results, we choose 2007–2011 as our study period. The listed company is the object of our study. Considering the validity of the conclusions, we do the following screening:

1. Been excluded in the 2007–2011 ST,* ST and PT listed manufacturing companies;
2. Eliminate listed for less than 5 years of manufacturing listed companies;
3. Delete manufacturing listed companies which financial data is not complete. After the screening we received a total of 455 valid samples.

3.2 Model Specification and Variable Definitions

A large number of domestic and foreign literature have been confirmed that the Cobb-Douglas production function effectively found the relationship between enterprise absolute amount of input and output (Cobb and Douglas 1928). Griliches, Bitzer and Kerekes, Tronconi and Marzetti, Lee studied the effects of R&D investment for the firm's output based on the model (Griliches 1986; Bitzer and Kerekes 2008; Tronconi and Marzetti 2011; Lee 2011). However, Branstetter and Sakakibara founds that it's a positive impact of market-oriented to technological innovation (Branstetter and Sakakibara 2002). Considering the influence of the market to the technological innovation, the paper will add the degree of marketization to Cobb-Douglas production function, and construct the development Cobb-Douglas production function, and the specific model is as follows:

$$Q = AL^{\alpha} K^{\beta} R^{\gamma} I^{\rho} \tag{1}$$

Which Q indicates the level of output, A is constant, L is labor inputs, K is capital investment, R is R&D investment, I is the extent of the market-oriented. In order to construct linear regression equation and test the relationship between R&D investment and output, the production function model was taken on both sides of the logarithm, and gets a logarithmic form linear model:

$$\ln Q = \ln A + \gamma \ln R + \alpha \ln L + \beta \ln K + \rho \ln I + \varepsilon \tag{2}$$

Among them, the Q is output level on behalf of the enterprise, based on enterprise's R&D investment for measure; A is constant term; R is R&D investment, based on main business income for measure; L is for enterprise labor input, based on the number of employees as a measure; K is on behalf of the enterprise capital investment, based on the enterprise total assets as a measure; I represent the degree of marketization, In this article we use the degree of marketization of the book "China market index" written by fan gang as a measure (Fan et al. 2011).

4 Empirical Results and Analysis

4.1 Descriptive Statistics of Variables

Table 1 shows the variable descriptive statistics of the proposed model (2). Where the average of R&D investment (ln*R*) is 16.303, the minimum is only 9.753, maximum value is 21.379, shows that investment in research and development

Table 1 Descriptive statistics of variables

Variable	Mean	Median	Min	Max	Std.D
lnQ	21.375	21.201	18.561	26.798	1.407
lnR	16.303	16.417	9.753	21.379	1.753
lnL	7.780	7.774	3.178	11.405	1.222
lnK	21.794	21.678	19.345	26.487	1.188
lnI	2.131	2.189	0.968	2.468	0.346

Table 2 Variable correlation test

Variable	*lnQ*	*lnR*	*lnL*	*lnK*	*lnI*
lnQ	1.000	0.557***	0.508***	0.639***	0.089**
lnR	0.496***	1.000	0.379***	0.563***	−0.043
lnL	0.551***	0.380***	1.000	0.640***	0.077
lnK	0.610***	0.521***	0.696***	1.000	0.099**
lnI	0.082**	−0.073	0.039	0.021	1.000

Notes: Diagonal above is Pearson correlation coefficient below Spearman correlation coefficient; ***, **, * indicate significance at the 1 %, 5 % and 10 % levels, respectively (two-tailed test)

of China's manufacturing industry listed company is uneven which has some differences. And the corresponding level of output (ln*Q*) shows a larger gap, the minimum is only 18.561, and the maximum value is as high as 26.798.

4.2 Variable Correlation

In order to test the multicollinearity that may exist between the variables, we do the correlation test. Table 2 shows the results of correlation test for the model (2). This paper uses the Pearson correlation test and Spearman correlation test to examine the variables involved in the model. The result shows the correlation coefficients between all of variables were less than 0.8. According to the principle of multicollinearity discriminator, the variables in the present model do not have multicollinearity problem. Based on the above findings, we can do regression analysis.

4.3 Regression Analysis Results

Table 3 is the OLS regression analysis for the cumulative effect of R&D inputs performance. From the table, we can find that the cumulative effect coefficient of R&D investment is 0.03, which have passed the test of significance level of 5 %; the cumulative effect coefficient of R&D investment which has two cumulative terms is 0.034,has a significance impacted the 5 % level; the coefficient is 0.036 which has three cumulative terms, passed the test of significance at the 1 % level; the coefficient is 0.059 which has four cumulative terms, passed the test of significance at the 1 % level. In summary, we found that the current period to the cumulative effect coefficient respectively is 0.03, 0.034, 0.036, and 0.059. We can intuitively found that it has a long-term cumulative effects for corporate R&D investment, which there has a largest effect when R&D inputs performance is a cumulative four

Table 3 Regression analyses for cumulative effects of R&D investment performance

	Current cumulative		Two cumulative		Three cumulative		Four cumulative	
Variable	Coefficient	VIF	Coefficient	VIF	Coefficient	VIF	Coefficient	VIF
Intercept	−1.411***		0.358		−1.976***		−2.411**	
	(−3.364)		(0.680)		(−2.632)		(−2.228)	
lnR	0.030**	1.486	0.034**	1.612	0.036***	1.483	0.059***	1.644
	(2.057)		(1.995)		(2.752)		(2.728)	
lnL	0.209***	1.695	0.240***	1.791	0.160***	1.869	0.146***	1.712
	(9.432)		(7.687)		(3.763)		(2.633)	
lnK	0.950***	2.151	0.862***	2.412	0.996***	2.367	0.994***	2.334
	(37.007)		(24.968)		(20.862)		(14.749)	
lnI	0.012*	1.025	0.010**	1.029	0.013**	1.031	0.087*	1.038
	(1.652)		(2.109)		(1.994)		(1.680)	
F	1032.220***		563.726***		338.539***		168.888***	
Adj-R^2	0.901		0.861		0.882		0.882	
D.W	2.178		1.772		2.189		2.266	
Obs	455		364		273		182	

Notes: ***, **, * indicate significance at the 1 %, 5 % and 10 % levels, respectively (two-tailed test)

terms, and the effect was most significant ($p = 0.000$). This means that the R&D investment in 4 years can generate a positive role in promoting the performance of enterprises and can not play an active role after 4 years.

5 Conclusion

This paper selects 455 manufacturing firms in Shanghai and Shenzhen Stock Exchanges from 2007 to 2011 as study object, and establishes a modified Cobb-Douglas production function considering the degree of market-oriented factors, using OLS regression analysis found: there has a significant cumulative effect of corporate R&D investment performance; Within 4 years of R&D investment plays a significant role in promoting on firm performance, in the fifth year of this effect is not significant. The main contributions of this paper are following two aspects: the one hand, the degree of market factors cited the Cobb-Douglas production function, considered the impact of institutional environment factors for enterprise production during the transition period, and provide a new perspective and tools for the research of enterprise inputs; on the other hand, this paper fills the blank field about cumulative effect of R&D investment performance, found the cumulative effect characteristics of enterprise R&D investment performance, and laid a foundation for the follow-up in-depth study.

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Modeling and Simulation of a Centralized Supply Chain Distribution System for a Single Product in Uncertain Demand

Zhi-gao Liao, Xi-gang Yuan, and Xiao-qing Zhang

Abstract This paper describes modeling and simulation of a centralized supply chain distribution system for a single product in uncertain demand. A supply chain distribution system cost optimization model is developed in this concern, which includes multiple manufacturers, multiple distribution centers and multiple retailers. To provide a more realistic model structure, decision makers' thinks that the distribution centers and retailers appears out of stock at the same time. With the MatLab 2010(a) carrying on the model, analyzing the influence which the order proportions and transportation cost in distribution centers and retailers to the supply chain distribution system total cost. As a result, on the one hand, when the order proportion is in the middle, the total cost is in the lowest level in supply chain distribution system. On the other hand, the order proportion is up and down, the total cost is no obvious change in supply chain distribution system. On the contrary, when the transportation cost usually is in the middle, the total cost is the lowest level in supply chain distribution system.

Keywords Distribution system • Modeling and simulation • Supply chain • Uncertainty demand

1 Introduction

In the globalization market competition, the competitions between enterprises are no longer the competition between individual enterprises but the competition between enterprises in supply chain. Because the cooperation between supply chain

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members can significantly improve the performance of supply chain inventory control, therefore, integrated inventory model is attracted to the attention of scholars.

While many inventory modeling problems have been discussed extensively in the literature, the treatment of interaction among the buyers and suppliers of an item is still in its infancy (Goyal and Gupta 1989). When the vendor and the buyer inventory problem are treated in isolation, under the deterministic condition, it is well known that the economic order quantity (EOQ) formula gives an optimal solution. But in case that an optimal EOQ solution for the buyer is unacceptable to the vendor and the optimal EOQ solution for the vendor is unacceptable to the buyer. In a typical situation the vendor and the buyer think both price and size; the result depends on the balance of power between the vendor and the buyer (White 1971). In some times, through agreements to coordinate the relationship between the vendor and the buyer, from the vendors point of view, Monahan (1984) developed an inventory control model based on the vendor minimum cost. Banerjee (1986) developed Monahan's model that incorporated vendors inventory control cost. After that, Lee and Rosenblatt (1986) get rid of Monahan and Banerjee's assumption. At the same time, Lal and Staelin (1984), Rosenblatt and Lee (1985) and Kim and Hwang (1988) proposed several inventory control models based on special forms of discount price structures.

In recent years, integrated inventory model is becoming a hot spot problem in supply chain management field. The integrated inventory model is that on the basis of mutual coordination in the buyers and sellers for their production, distribution and order decision-making, through optimizing to improve the speed and certainty in all the inventory related processes, to maximize the net value of all process, improve the efficiency and effectiveness of the organization, as a result that it can achieve the minimum total cost in the supply chain. In integrated inventory research, modeling and optimization of the integrated distribution system is becoming more and more aroused peoples concern. All kinds of literature by choosing different program to set environment in the supply chain management so that can analysis the distribution system. Viswanathan (1998) proposed the optimal strategy which included an integrated vendor's and buyer's inventory model, the goal of the model was that made the minimize of the combined average annual total cost. The vendor's production adjustment cost, buyer's order cost, inventory holding cost in buyers and vendor's were included in the total cost. Woo et al. (2001) considered that the vendors material inventory holding costs which was included in the total cost. It assumed that the buyer's demand rate was a constant and the vendor's productivity was also a constant. The disadvantage of the above research was that the demand was certainty. It did not consider the shortage cost and transportation cost. But actually in the distribution system, the shortage cost and transportation cost were also happen and one or more members should burden the cost. Tyworth and Zeng (1997) made up the defect, the transportation time as a part of the lead time in the model, analysis the total cost of the joint optimization problem which included the transportation cost, holding cost, ordering cost, shortage cost. Based on it, the inventory and transportation decision-making logistics system cost model was put forward. A goal out of stock can be seen as constraint. But it only considered "one- to- one" distribution system which included one vendor and one distribution center and one retailer.

The above research were based on the certainty demand, as known to us, with the changing market environment, many variables of supply chain distribution system become uncertainty. Wang Lei and Zhao Xiao bo (2008), considered when the customer requirements was in random, the optimization strategy come up with the inventory cost. As a result, the linear programming model was established. Gu Weitao and Xu Guohua (2005) generalized wang's model by control each store cost both vendors and buyers. In addition, Chang Liangfeng et al. (2004), from the perspective of supply chain coordination, come up with the two level supply chain Stackelberg model, consider the cumulative price discount and the buyer's inventory cost rationalization in the model. Wan Jie et al. (2010) generalized huang's model by considering the retailer's order fill rate and total supply chain inventory cost. Using the Opt Quest determined each retailer's optimal order point and order quantity and optimized the total cost of the supply chain.

This paper considers another case in which the distribution center and retailer appears out of stock at the same time and the demand is uncertainty. The objective is to minimize the supply chain distribution system total cost. The constraint conditions is the distribution center's and the retailer's service. The cost optimization model is introduced in Sect. 2, and in order to solve this model, assumes that the distribution center's demand and the retailer's demand is uncertainty. Based on it, the second order partial derivatives were solved for the objective function. After that, it analysis the influence that order ratio and transport ratio is to the total cost in the supply chain distribution system. As a result, on the one hand, when the order proportion is in the middle, the total cost is in the lowest level in supply chain distribution system. On the other hand, the order proportion is up and down, the total cost is no obvious change in supply chain distribution system. On the contrary, when the transportation cost usually is in the middle, the total cost is the lowest level in supply chain distribution system.

2 Problem Description and Model Assumption and Symbol Instruction

In a multi-vendors, multi-distribution centers and multi-retailers integrated inventory problem, there are L vendors M distribution centers and N retailers in the supply chain distribution system. Out of stock in distribution centers and retailers is allowed. In order to instruct the problem, we assume that distribution centers and retailers adopt continuous review inventory control strategy. Distribution center does not meet the needs of retailers, distribution centers appear shortage. Retailers does not meet the needs of customers, retailers appear shortage. Regardless of the manufacturers' inventory holding cost and shortage cost. The proportion of different manufacturers to the distribution center is determined. The proportion of different distribution center to the retailers is certain. Average daily in the distribution center and retailer, ordering lead time demand is normal distribution independently, their mean and variance can be estimated. Distribution centers and retailers of transport services by a third party transportation company are achieve the small batch delivery. Each distribution center is in great demand, but assumes that the annual demand is quantity of integer times. Retailers as well as various distribution centers, are in great demand, but assume that the annual demand is integer. Manufacturer i $(i = 1,2,\ldots l)$ can be expressed M_i. Distribution center j $(j = 1,2\ldots m)$ can be expressed D_j. retailer k $(k = 1,2\ldots n)$ can be expressed R_k. The demand of distribution center D_j is A_j, it is equal to 360 multiplied by the annual demand. The demand of the retailer R_k is B_k, it is equal to 360 multiplied by the annual demand. Each time fixed quantity order is Q_j in the distribution center D_j. Each time fixed quantity order in the retailer R_k is P_k. a_{ij} is the annual demand A_j of distribution centers D_j, which is supplied the amount of goods by the manufacturer M_i where $a_{ij} = A_j * \lambda_{ij}$. b_{jk} is the annual demand B_k of retailers B_k, which is supplied the amount of goods by the distribution center D_j where $b_{jk} = B_j * \mu_{jk}$. q_{ij} is the quantity Q_j of goods in the distribution center D_j, which is supplied by the amount of the manufacturer M_i, where $q_{ij} = Q_j * \lambda_{ij}$. p_{jk} is the retailer's R_k order quantity P_k, which is supplied by the amount of goods in the distribution center D_j, where $p_{jk} = P_k * \mu_{jk}$. A_j/Q_j is the order number for the distribution center D_j from the manufacturers M_i. B_k/P_k is the order number of retailer R_k from the distribution center D_j. W_j is the reorder point level of distribution center D_j. WW_j is the safety stock in the distribution centers D_j. S_k is the reorder point level of retailer R_k. SS_k is the safety stock in the retailer R_k. α_j is the target stock risk (%) in the distribution center D_j. V_j is the safety stock factor of the distribution center D_j. β_k is the target stock risk (%) in the retailer R_k. η_k is the safety stock factor of the retailer R_k. EU_j is expected shortage quantity in the distribution center D_j. ES_k is the expected shortage quantity in the retailer R_k. K_{mi} is the order processing cost in distribution center from the manufacturer M_i $(i = 1,2,\ldots l)$. G_{dj} is the order processing cost in retailer from the distribution center D_j $(j = 1,2\ldots m)$. Z_{dj} is the order process cost in each time order of distribution center. D_j $(j = 1,2\ldots m)$. X_{rk} is the order process cost in each time order of the retailer R_k $(k = 1,2,\ldots n)$. V is the factory products price in the various manufacturer M_i $(i = 1,2,\ldots l)$. C_j is the unit inventory holding cost of unit value percentage in the distribution center D_j $(j = 1,2\ldots m)$. E_j is the inventory holding cost of unit value percentage in the distribution center D_j $(j = 1,2\ldots m)$. T_k is the unit inventory holding cost of unit value in percentage in the retailer R_k $(k = 1,2\ldots n)$ Y_k is the inventory holding cost of unit value in percentage in the retailer R_k $(k = 1,2\ldots n)$. O_j is the unit cost of late delivery penalty percentage in the distribution center D_j $(j = 1,2\ldots m)$. N_k is the unit value cost of late delivery penalty percentage in retailer R_k. F_j is the delay order percentage in distribution center D_j. H_k is the delay order percentage in retailer R_k. PP is the unit mass. $f(Q_j)$ is the Unit distance freight function. HH is the discount rate. KK_{ij} is the distance between manufacturer and distribution center. AA_{jk} is the distribution between retailer and distribution center. ESD_j is the expected service level of the distribution center j.

TSD_j is the target service level of the distribution center j. ESR_k is the expected service level of the retailer k. TSR_k is the target service level of the k retailer k. $J(Q_1,Q_2,\cdots,Q_m,P_1,P_2,\cdots,P_k)$ is the expected total cost in the distribution system. θ_j is the distribution center D_j ahead of midterm fixed order processing time(day). τ_k is the retailers R_k ahead of midterm fixed order processing time(day). ϑ_j is the: distribution center D_j lead time(days) is the mean $\xi_{\vartheta j}$ and variance $\delta_{\vartheta j}$ of random variable and respectively. ψ_k is the retailer's R_k lead time(days), is the mean $\xi_{\psi k}$ and variance $\delta_{\psi k}$ of random variable and respectively. O_j is the distribution center D_j for shipping time(days), is the mean ξ_{Oj} and variance δ_{Oj} and random variables respectively. η_k is the retailer's R_k transport time(day), is the mean $\xi_{\eta k}$ and variance $\delta_{\eta k}$ of random variable and respectively a_j is the distribution centers D_j of demand, is the mean ξ_{aj} and variance δ_{aj} and random variables respectively. b_k is the:retailer's R_k demand, is the mean ξ_{bk} and variance δ_{bk} of random variable and respectively. c_j is the distribution center order lead time demand, is the mean ξ_{cj} and variance δ_{cj} of random variable and respectively. d_k is the retailers ordering lead time demand, the mean ξ_{dj} and variance δ_{dj} of random variance and respectively.

3 Mathematical Model and Derived Formula

As is known to us, in a multi-vendors, multi-distribution centers and multi-retailers integrated inventory problem, there are L vendors, M distribution centers and N retailers in the supply chain distribution system. The expected total cost in the distribution system includes the distribution system order cost C_o, distribution center's inventory holding cost C_{hD}, retailer's inventory holding cost C_{hK}, distribution center of transportation cost C_{tD}, retailer's transportation cost C_{tR}, the shortage cost of distribution center C_{vD}, the shortage cost of retailers C_{vR}. The distribution system order cost C_o satisfies

$$C_o = \sum_{i=1}^{L}\sum_{j=1}^{M} k_{mi}\frac{A_j\lambda_{ij}}{Q_j\lambda_{ij}} + \sum_{j=1}^{M}\sum_{i=1}^{L} z_{dj}\frac{A_j\lambda_{ij}}{Q_j\lambda_{ij}} + \sum_{j=1}^{M}\sum_{k=1}^{N} G_{dj}\frac{B_k\mu_{jk}}{P_k\mu_{jk}} + \sum_{k=1}^{n}\sum_{j=1}^{m} X_{rk}\frac{B_k\mu_{jk}}{P_k\mu_{jk}} \tag{1}$$

Where the distribution system order cost C_o includes the manufacturer's order processing const and order cost of distribution center and order cost of distribution center and retailer order cost. Ordering cost is order number multiplied by the unit price of other ordering costs. The distribution center's inventory holding costs C_{hD} satisfied

$$C_{hD} = \sum_{j=1}^{M}\left(Q_j/2 + WW_j\right)^* V^* C_j + \sum_{j=1}^{M}\left(\xi_{oj}{}^*\xi_{aj}\right)^* V^* E_j \tag{2}$$

Where the distribution center's inventory holding cost C_{hD} includes average distribution center inventory, unit product value and the inventory holding cost of unit product value, and the sum of the inventory holding cost.

The retailer's inventory holding cost C_{hK} satisfies

$$C_{hK} = \sum_{k}^{N} (p_k/2 + SS_k)^* V^* T_k + \sum_{k=1}^{N} (\xi_{bk}{}^* \eta_k)^* V^* Y_k \tag{3}$$

Where the retailer's inventory holding cost C_{hK} includes the retailer's average inventory level, unit product value and the inventory holding cost as a percentage of the product and the inventory holding cost.

The distribution center of transportation cost C_{tD} satisfies

$$C_{tD} = \sum_{j=1}^{M} \sum_{i=1}^{L} f(q_{ij})^* pp_{ij}{}^* KK_{ij}{}^* (1 - HH)^* \frac{A_j \lambda_{ij}}{Q_j \lambda_{ij}} \tag{4}$$

Where the transportation cost is the capacity $f(s) * (1-d)$ is for s freight discount and for d when the unit weight of freight is in unit disturbance function, the power function form is $f(s)^* (1-d) = a_1 (w^* s)^{b_1 *} (1-d)$ (a_1, b_1 is for the undetermined parameter $a_1 > 0$, $-1 < b_1 < 0$) $\frac{A_j a_{ij}}{Q_j a_{ij}}$ can expect the annual order number, the distance can be multiplied by the total weight and obtained the distribution center for shipping cost.

The retailer's transportation cost C_{tR} satisfies

$$C_{tR} = \sum_{k=1}^{N} \sum_{j-1}^{M} f(p_{jk})\, w_{jk}{}^* pp_{jk}{}^* AA_{jk}{}^* (1 - HH)^* \frac{B_k \mu_{jk}}{P_k \mu_{jk}} \tag{5}$$

Where the transportation cost is the capacity $f(s) * (1-d)$ is for s freight discount and for d when the unit weight of freight in unit disturbance function, the power function form is $f(s)^* (1-d) = a_2 (w^* s)^{b_2 *} (1-d)$ (a_2, b_2; $a_2 > 0$, $-1 < b_2 < 0$) $\frac{B_k b_{jk}}{P_k b_{jk}}$ is for the undetermined parameters ($a_1 > 0$, $-1 < b_1 < 0$) $\frac{A_j a_{ij}}{Q_j a_{ij}}$ can expect the annual order number, they distance multiplied by the total weight and obtains the retailer center for shipping cost.

The shortage cost of distribution center C_{vD} satisfies

$$C_{vD} = \sum_{j=1}^{M} F_j{}^* EU_j{}^* \frac{A_j}{Q_j}{}^* V^* O_j + \sum_{j=1}^{M} (1 - F_j)^* EU_j{}^* \frac{A_j}{Q_j}{}^* \left(\sum_{i=1}^{L} V^* \lambda_{ij} \right) \tag{6}$$

Where the shortage cost of distribution center C_{vD} includes the loyal customer delay delivery cost and corresponds to the loyal customer sales loss in two parts, the first is said to postpone the ordering cost, the second is said to the sales of losses, and distribution center expected that stock quantity and the proportion of delay order.

The shortage cost of retailer C_{vR} satisfies

$$C_{vR} = \sum_{k=1}^{N} H_k{}^* ES_k{}^* \frac{B_k}{p_K}{}^* V^* N_k + \sum_{k=1}^{N} (1 - H_k)^* ES_k{}^* \frac{B_k}{P_k}{}^* \left(\sum_{i=1}^{M} V^* \mu_{jk} \right) \quad (7)$$

Where the shortage cost of retailer C_{vR} includes the loyal customer delay delivery cost and corresponds to the loyal customer sales cost is in two parts, the first is said to postpone the ordering cost, the second is said to sales loss, arising out of the retailer's expected shortage quantity proportion and delay the order.

In order to get the whole distribution systems' minimize total cost and to meet the service level constraint $Q_1, Q_2, \cdots Q_m, P_1, P_2, \cdots, P_n$, get the following cost minimization model.

$$\begin{aligned}
&J\left(Q_1, Q_2, \cdots, Q_m, P_1, P_2, \cdots, P_k\right) = \\
&\sum_{i=1}^{L} \sum_{j=1}^{M} k_{mi} \frac{A_j}{Q_j} + \sum_{j=1}^{M} \sum_{i=1}^{L} z_{dj} \frac{A_j}{Q_j} + \sum_{j=1}^{M} \sum_{k=1}^{N} G_{dj} \frac{B_k}{P_k} + \sum_{k=1}^{N} \sum_{j=1}^{M} X_{rk} \frac{B_k}{P_k} \\
&\quad + \sum_{j=1}^{M} \left(Q_j/2 + WW_j\right)^* V^* C_j + \sum_{j=1}^{M} \left(\xi_{oj}{}^* \xi_{aj}\right)^* V^* E_j \\
&\quad + \sum_{k}^{N} (p_k/2 + SS_k)^* V^* T_k + \sum_{k=1}^{N} (\xi_{bk}{}^* \eta_k)^* V^* Y_k \\
&\quad + \sum_{j=1}^{M} \sum_{i=1}^{L} a\left(Q_j{}^* pp_{ij}{}^* \lambda_{ij}\right)^{b*} KK_{ij}{}^* (1 - HH)^* \tfrac{A_j}{Q_j} \\
&\quad + \sum_{k=1}^{N} \sum_{j=1}^{M} a\left(p_k{}^* w_{jk}{}^* \mu_{jk}\right)^{b*} AA_{jk}{}^* (1 - HH)^* \frac{B_k}{P_k} \\
&\quad + \sum_{j=1}^{M} F_j{}^* EU_j{}^* \tfrac{A_j}{Q_j}{}^* V^* O_j + \sum_{j=1}^{M} \left(1 - F_j\right)^* EU_j{}^* \frac{A_j}{Q_j}{}^* \left(\sum_{i=1}^{L} V^* \lambda_{ij} \right) \\
&\quad + \sum_{k=1}^{N} H_k{}^* ES_k{}^* \frac{B_k}{p_K}{}^* V^* N_k + \sum_{k=1}^{N} (1 - H_k)^* ES_k{}^* \frac{B_k}{P_k}{}^* \left(\sum_{i=1}^{M} V^* \mu_{jk} \right)
\end{aligned} \quad (8)$$

Subject to

$$ESD_j\left(Q_j\right) \geq TSD_j \quad (9)$$

$$ESR_k\left(P_k\right) \geq TSR_k \quad (10)$$

$$Q_j > 0 \quad (11)$$

$$R_k > 0 \quad (12)$$

4 The Salvation of the Distribution System Model

In order to find the optimal quantity of goods in distribution center and retailer, using the Lagrange multiplier method to solve the model, the final results is as follow:

$$\begin{aligned}\frac{\partial^2 J}{\partial Q_j^2} &= 2\sum_{i=1}^{L}\sum_{j=1}^{M} K_{mi}\, Q_j^{-3} A_j + 2\sum_{j=1}^{M}\sum_{i=1}^{L} Z_{dj}\, Q_j^{-3} A_j + a^* (b-1)^* (b-2)^* \\ & pp_{ij}{}^{b*} (1{-}HH)^* \sum_{j=1}^{M}\sum_{i=1}^{L} Q_j^{b-3*} KK_{ij}{}^* A_j + 2\sum_{j=1}^{M} F_j{}^* EU_j{}^* \frac{A_j}{Q_j^3}{}^* V^* O_j \\ & + 2\sum_{j=1}^{M} \left(1-F_j\right)^* EU_j{}^* \tfrac{A_j}{Q_j^3}{}^* \sum_{i=1}^{L} V^* \lambda_{ij}\end{aligned} \tag{13}$$

From the formula (8) we can get the partial result

$$\begin{aligned}\frac{\partial^2 J}{\partial P_k^2} &= 2\sum_{j=1}^{M}\sum_{k=1}^{N} G_{dj}{}^* B_k{}^* P_k^{-3} + 2\sum_{k=1}^{N}\sum_{j=1}^{M} X_{rk}{}^* B_k{}^* P_k^{-3} + a^* (b{-}1)^* (b{-}2)^* \\ & + 2\Big(\sum_{k=1}^{N} (1-H_k)^* ES_k{}^* \frac{B_k}{P_k^3}{}^* \sum_{i=1}^{M} V^* \mu_{jk}\Big)\end{aligned} \tag{14}$$

By the formula (14) right side is the convex function, as a result, it can make the first order partial derivative which is zero, find distribution center from the manufacturer's optimal order quantity Q_j, the optimal order quantity P_k that is the retailer from the distribution center.

$$\frac{\partial J}{\partial Q_j} = \left\{\begin{aligned} & \Big\{-\sum_{i=1}^{L}\sum_{j=1}^{M} K_{mi} \frac{A_j}{Q_j^2} - \sum_{j=1}^{M}\sum_{i=1}^{L} Z_{dj} \frac{A_j}{Q_j^2} + \sum_{j=1}^{M}\left(\frac{1}{2} + WW_j\right) \\ & {}^* V^* C_j + a^* (b-1)^* pp_{ij}^{b*} (1-HH) \\ & {}^* \sum_{k=1}^{N}\sum_{j=1}^{M} Q_j^{b-2*} KK_{ij}{}^* A_j - \sum_{j=1}^{M} F_j{}^* EU_j{}^* \frac{A_j}{Q_j^2}{}^* V^* O_j = 0 \\ & + \sum_{j=1}^{M} \left(1-F_j\right)^* EU_j{}^* \frac{A_j}{Q_j^2}{}^* \sum_{i=1}^{L} V^* \lambda_{ij}\end{aligned}\right. \tag{15}$$

$$\frac{\partial J}{\partial P_k} = \left\{\begin{aligned} & -\sum_{j=1}^{M}\sum_{k=1}^{N} G_{dj} \frac{B_k}{P_k^2} - \sum_{k=1}^{N}\sum_{j=1}^{M} X_{rk} \frac{B_k}{P_k^2} + \sum_{k=1}^{N}\left(\frac{1}{2} + SS_k\right) \\ & {}^* V^* T_K + a^* (b-1)\, w_{jk}^{b}{}^* (1-HH) \\ & {}^* \sum_{k=1}^{N}\sum_{j=1}^{M} P_k^{b-2*} AA_{jk}{}^* B_k - \sum_{k=1}^{N} H_k{}^* ES_k{}^* \frac{B_k}{P_k^2}{}^* V^* N_k = 0 \\ & + \sum_{k=1}^{N} (1-H_k)^* ES_k{}^* \frac{B_k}{P_k^2}{}^* \left(\sum_{i=1}^{M} V^* \mu_{jk}\right)\end{aligned}\right. \tag{16}$$

5 Optimal Solution for Three-Vendors Three-Distribution Centers and Three-Retailers Case

While finding the optimal solution for the multiple-vendors, multiple-distribution centers and multiple-retailers case are difficult, we can find the optimal solution for the three-vendors, three-distribution centers and three-retailer case.

In order to instruct the case, we give the figure one is as follow in (Fig. 1).

In order to illustrate the problem, we assumes that the target risk out of stock is $\alpha_1 = 2.3\ \%$ in the distribution center D_1, the target risk out of stock is $\alpha_2 = 2.5\ \%$ in the distribution center D_2, the target out of stock is $\alpha_3 = 2.6\ \%$ in the distribution center D_3, the target risk out of stock is $\beta_3 = 3.5\ \%$ in the retailer R_3, the target risk out of stock is $\beta_1 = 2.8\ \%$ in the retailer R_1, the target risk out of stock is $\beta_2 = 3\ \%$ in the retailer R_2. Other related variables are shown in the following table (Table 1).

Among them, the target service level in the distribution center one, distribution center two, distribution center three is that

$$TSD_1 = 1–2.3\ \% = 97.7\ \%, TSD_2 = 1–2.5\ \% = 97.5, TSD_3 = 1–2.6\ \% = 97.4$$

The target service level in the retailer one, retailer two and retailer three is that

$$TSR_1 = 1–2.8\ \% = 97.2\ \%, TSR_2 = 1–3\ \% = 97\ \%, TSR_3 = 1–3.5\ \% = 96.5\ \%$$

The safety stock in the distribution centers corresponding factor is that $V_1 = 1.9, V_2 = 2, V_3 = 1.9$, the safety stock in the retailers corresponding factor is that $\eta_1 = 1.9, \eta_2 = 1.8, \eta_3 = 1.8$, so the safety stock and reorder point respectively in the distribution centers is that

$$WW_1 = V_1 * \delta_{\vartheta 1} = 1.9 * 0.02 = 0.038, WW_2 = V_2 * \delta_{\vartheta 2} = 2 * 0.62 = 1.24,$$
$$WW_3 = 1.9 * 0.58 = 1.102, W_1 = 1 + WW_1 = 1.038, W_2 = 1 + WW_2 = 2.24,$$
$$W_3 = 1 + WW_3 = 2.102$$

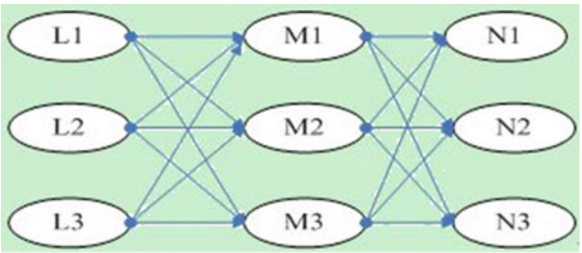

Fig. 1 The distribution system includes three-vendors, three distribution centers and three-retailers

Table 1 The related variables in the model

Parameter	Parameter value	Parameter	Parameter value
A_1	360	B_1	500
A_2	480	B_2	520
A_3	440	B_3	620
PP	70	V	6,000
a_1	132.917	b_1	−0.6428
a_2	130.702	b_2	−0.5203
HH	10 %	Q_j	4
T_k	5	$\xi_{\vartheta 1}/\delta_{\vartheta 1}$	1/0.02
$\xi_{\vartheta 2}/\delta_{\vartheta 2}$	1/0.62	$\xi_{\vartheta 3}/\delta_{\vartheta 3}$	1/0.58
$\varepsilon_{\psi 1}/\delta_{\psi 1}$	1/0.48	$\varepsilon_{\psi 2}/\delta_{\psi 2}$	1/0.58
$\varepsilon_{\psi 3}/\delta_{\psi 3}$	1/0.63	$\varepsilon_{a1}/\delta_{a1}$	1/0.71
$\varepsilon_{a2}/\delta_{a2}$	1/0.52	$\varepsilon_{a3}/\delta_{a3}$	1/0.69
$\varepsilon_{b1}/\delta_{b1}$	1/0.48	$\varepsilon_{b2}/\delta_{b2}$	1/0.54
$\varepsilon_{b3}/\delta_{b3}$	1/0.67	$\varepsilon_{c1}/\delta_{c1}$	1/0.48
$\varepsilon_{c2}/\delta_{c2}$	1/0.56	$\varepsilon_{c3}/\delta_{c3}$	1/0.66
$\varepsilon_{d1}/\delta_{d1}$	1/0.46	$\varepsilon_{d2}/\delta_{d2}$	1/0.52
$\varepsilon_{d3}/\delta_{d3}$	1/0.58	C_1	60 %
C_2	50 %	C_3	56 %
T_1	54 %	T_2	68 %
T_3	72 %	E_1	18 %
E_2	22 %	E_3	23 %
Y_1	16 %	Y_2	18 %
Y_3	22 %	K_{m1}	25
K_{m2}	25	K_{m3}	25
G_{d1}	20	G_{d2}	20
G_{d3}	20	Z_{d1}	18
Z_{d2}	18	Z_{d3}	18
X_{r1}	20	X_{r2}	20
X_{r3}	20	O_1	18 %
O_2	18 %	O_3	18 %
N_1	10 %	N_2	10 %
N_3	10 %	F_1	80 %
H_1	75 %	ξ_{O1}/δ_{01}	5/0.78
ξ_{O2}/δ_{02}	5/0.56	ξ_{O3}/δ_{03}	4/10.47

the safety stock and reorder point respectively in the retailers is that

$$SS_1 = \eta_1 * \delta_{\psi 1} = 1.9 * 0.48 = 0.912, SS_2 = \eta_2 * \delta_{\psi 2} = 1.8*0.58 = 1.044,$$
$$SS_3 = \eta_3 * \delta_{\psi 3} = 1.8*0.63 = 1.134, S_1 = 1 + SS_1 = 1.912, S_2 = 1 + SS_2 = 2.044, S_3 = 1 + SS_3 = 2.134$$

We can get the $Q_1 = 14, Q_2 = 15, Q_3 = 12, P_1 = 17, P_2 = 20, P_3 = 23, J = 7950.4$ the quantity is the optimal order quantity request.

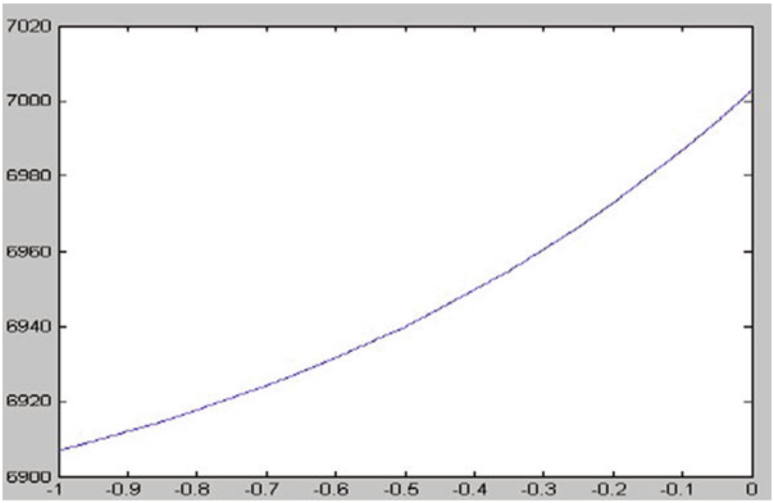

Fig. 2 Rate parameter sensitivity analysis

Face under the influence the related parameters of the distribution system do sensitivity analysis, about distribution center unit freight calculated parameters, the proportion and retailers, the unit price of order parameter and order effect on the total cost of the distribution system and trend.

5.1 Sensitivity Analysis About Distribution Center Unit Rate Parameter

The simulation result show that in Fig. 2, with the total cost is declining and decreased the size of the larger, this is because the fall resulting in a decline in the freight rate of the unit weight, and increased frequency of transport, to reduce quantity and quantity of goods to bring the average inventory level drop, the result will inevitably be reduced inventory holding cost.

5.2 The Order Proportional Sensitivity Analysis About Distribution Centers

With the change of distribution centers to manufacturers ordering ratio, the total cost of the distribution system changes is not to order from a manufacturer's rate increase will cause order from other manufacturers of changes, this changeis inevitable, as

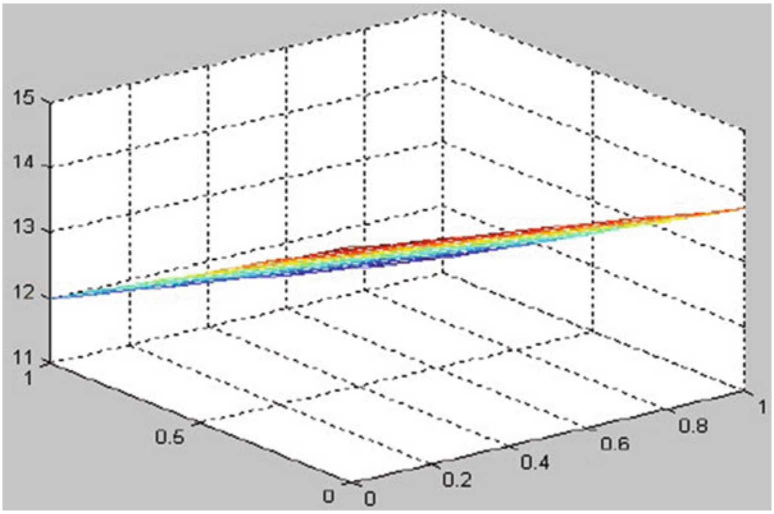

Fig. 3 Rate parameter sensitivity analysis

can be seen from the table as (Fig. 3), the scale of order is not the bigger the better, is not as small as possible, but in the middle of the certain numerical value is more appropriate.

5.3 Sensitivity Analysis in the Retailer from the Distribution Center of the Unit Rater of Parameter

The simulation results show that, with the total cost is declining and decreased the size of the larger, this is because the fall resulting in a decline in the freight rate of the unit range unit weight, and increased frequency of transport, to reduce quantity, and the increase of the quantity of goods also leads to reduced average inventory level, the result will inevitably be reduced inventory holding cost The result can be seen in Fig. 4.

5.4 Sensitivity Analysis in Retailer's Ordering Ratio

As the change of retailers to order proportion distribution center, the total cost of the distribution system changes is that from a distribution center in order rate increase will cause order from other distribution centers, the change of this kind of change is inevitable, it can be seen from the table, the order is the greater and the better, The result can be seen it Fig. 5.

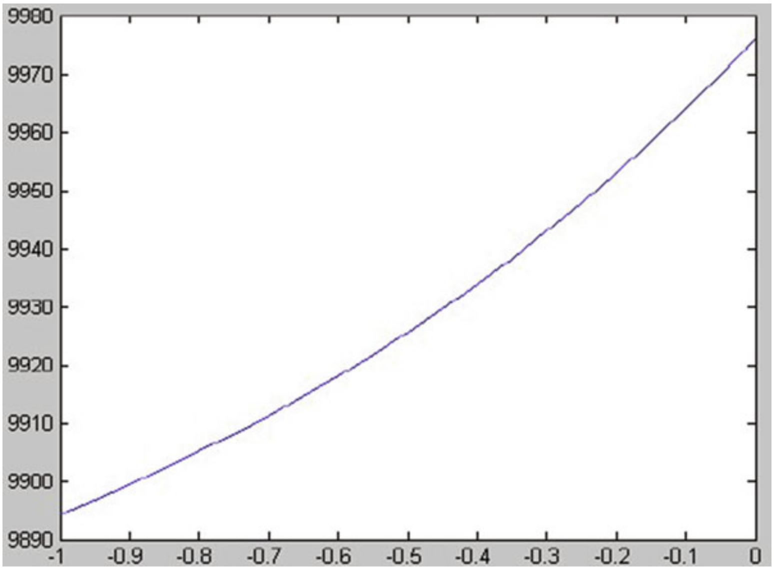

Fig. 4 Distribution centers of unit rate parameter sensitivity analysis

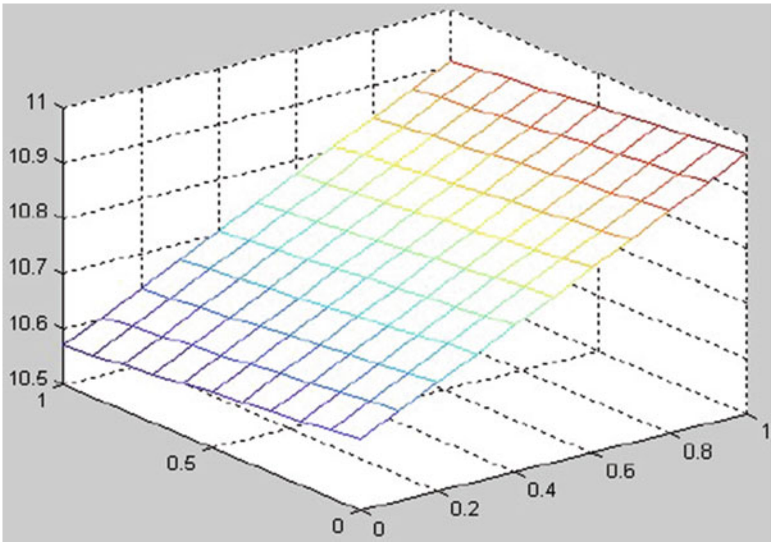

Fig. 5 Sensitivity analysis in retailer's ordering ratio

6 Conclusion

In this paper, we consider the distribution centers and retailers appear out of stock at the same time, changes the total cost of the distribution system which includes multiple manufacturers, multiple distribution centers and multiple retailers. We established the minimization cost supply chain model in the distribution system which is more close to actual situation, using the MatLab software simulation, analysis the influence that the transportation cost and order proportion for the total cost of the supply chain distribution system. We get that the order proportion is in the middle, the total cost is in the lowest level in supply chain distribution system. On the other hand, the order proportion is up and down, the total cost is no obvious change in supply chain distribution system. On the contrary, when the transportation cost usually is in the middle, the total cost is the lowest level in supply chain distribution system. The insufficient of the research is that we do not take many product factors in to account. The next step work is mainly on how the cost of the product supplies chain distribution system optimization problems in simulation.

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The Transformation Mode of the Export-Oriented Processing SMEs in Zhejiang Province: Based on Global Value Chain Theory

Ning Sun

Abstract This paper first defines the export-oriented processing SMEs (Small and Medium-sized Enterprises) and explain the global value chain theories. And then this paper analyzes the strengths and weaknesses of export-oriented processing SMEs in Zhejiang Province, goes on to look into the main factors that affect the export-oriented processing SMEs transformation from the perspective of the global value chain, this paper give evolutionary paths of exported-oriented processing SMEs. At last some suggests are given.

Keywords Export-oriented processing SMEs • Global value chain theory • Transformation mode

1 Introduction

Currently, the market environment changes are becoming more frequent, enterprises have rarely with a fixed strategic position and conservative forms of organization to maintain their competitive advantage in a long time. The implementation of the restructuring has become an important way to survival and development.

The U.S. subprime lending crisis has finally evolved into the global financial crisis and caused a great impact on the global economy. Though the direct impact of the crisis on China's economy is limit, as an open country whose dependence on foreign trade as high as 60 %, the financial crisis on China's economy has become more apparent. Zhejiang's economy is highly dependent on exports, and its export product in particular consists of traditional handicraft products and processed

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products, which is in the lower end of global value chains. So, many export-processing SMEs in Zhejiang inevitably suffer a serious beating in the global financial crisis.

Although the state has adopted many policies to create market conditions to encourage export enterprises, and the current global economy began to recovery slowly, but this study suggests that the transformation of enterprises from their own side is the important way to remain their competitive advantage and position. What are the possible evolutionary paths for export-oriented processing SMEs in Zhejiang Province? What are the main factors affecting the transformation of small and medium-sized enterprises? These are both questions worthy of thorough academic probing. At the same time, this paper will give some suggestions and measures on the transformation of the export-oriented processing SMEs in Zhejiang Province.

2 Theoretical Description

Firstly, this paper refers to the export-oriented processing SMEs is the enterprises who produce or assembly the materials and parts, and whose exports account for more than 50 % in the total annual sales. According to the research and investigation of many export-oriented processing enterprises of Zhejiang Province, we can find the following characteristics of Zhejiang export-oriented processing SMEs: the private enterprises is the majority, they are small in general, the enterprises have strong ability of elasticity and flexibility, they can quickly adjust their products to grasp the market, their main trade type is the processing trade, their main exports products are labor-intensive and resource-intensive products, lack of independent brands and independent R&D capability, a relatively low location in the global value chain, the financing channels are small, financial operations are weak. Because of these disadvantages, these SMEs are less able to resist risks.

Secondly, we will describe the global value chain theories. In 1985, Michael Potter first proposed the concept of value chain in his book "National Competitive Strengths" (Porter 2005). Gereffi (1999) put forth the concept of a global value chain based on Potter's theories (Gereffi 1999). In the Industrial Development Report 2002/2003: Competing Through Innovation and Learning the UNIDO pointed out the global value chain is a business network in which the value of products and services is realized and encompasses the production, sales and recycling, including the sourcing of materials, transport, the production and sales of half-processed goods, final consumption and recycling (United Nations Industrial Development Organization 2002).

According to global value chain theories, the global value chain can be divided into the technology link, the production link and the sales link (Giuliani et al. 2005). On the "smile curve" of global value chain, R&D and after-sale services occupy high value-added links, while processing and production is in the low value-added link. The key components processing and marketing is at the medium level of the value chain. Therefore small and medium-sized enterprises must move up to R&D and marketing links in order to reap greater added value and get a favorable position in the global labor division (Jian Zhang et al. 2007).

3 The Status Quo of Export-Oriented SMEs in Zhejang Province

The total import value of Zhejiang Province is $93.03 billion, and export accounts for $216.4 billion in 2011. In 2009, the general trade export of products stand at $176.48 billion and processing trade accounts for $24.91 billion. The general Trade is still the predominant trade form in Zhejiang province (Zhejiang Provincial Bureau of Statistics 2012) (See Table 1).

The three major export markets for Zhejiang Province are the European Union, the U.S. and Japan. In 2011, Zhejiang's exports to the EU are $50.77 billion, exports to U.S. are $40.42 billion, and exports to Japan are $13.34 billion. The detail of export markets of Zhejiang Province may See Table 2 from 2007 to 2011(Zhejiang Provincial Bureau of Statistics 2012).

From the export structure of Zhejiang province, the mechanical and electrical products account for 40.8 % of the total export, while clothing and textile products account for 30.5 %. Though mechanical, electrical and high-tech products are taking up a larger share and export structure is improving, export products are still low value-added and labor intensive on the whole. Only a tiny fraction of export products have the core technological features, independent intellectual property rights, their own brand and high added values. Most export products are still on low-end and low-price products in the global market.

Table 1 The total value of export trade of Zhejiang province (billion $)

	Export value				
Type of trade	2007	2008	2009	2010	2011
Total volume	128.27	154.27	133.01	180.46	216.34
Product trade	99.35	121.85	106.64	145.01	176.48
Processing trade	27.30	30.84	24.91	33.01	36.04

Source: 2012 Zhejiang statistical yearbook

Table 2 Main export market of Zhejiang province (billion $)

	EU	United States	Russia	Japan	ASEAN	Australia
2007	34.07	24.64	3.13	8.82	7.09	2.35
2008	42.65	26.54	4.27	9.96	8.74	2.95
2009	36.07	23.05	2.82	8.91	8.04	2.80
2010	48.32	30.45	51.11	10.55	11.01	37.15
2011	55.77	40.42	70.06	13.34	14.75	44.11

Source: 2012 Zhejiang statistical yearbook

4 The Dilemma of the Export-Oriented Processing Enterprises in Zhejiang Province

In view of the above analysis, there are many dilemmas of the export-oriented processing enterprises in Zhejiang Province.

The recovery of international market demand and slow global economic is uncertain. Data from Eurostat shows that the euro area and EU GDP growth has still decreased by 4.0 and 4.3 % in the third quarter in 2009. Corresponding time period, U.S. GDP fell 2.6 %. The rise in global demand is still relying on the support of government stimulation policies.

High trade protection barriers and intensified trade protectionism restrain the developing of export-oriented processing SMEs of Zhejiang Province in the international market. The data from the Ministry of Commerce of the People's Republic show there are 20 countries and regions that launched 107 trade remedy investigations against exports goods of China.

The export competitiveness was restrained because of the dollar depreciation and rising losts of raw materials. The depreciation of the dollar not only further weakened the advantage of the export prices in the U.S. market, but also pushed up prices of raw materials and labor costs. As the international market pick up, exports of Zhejiang began to increase. So enterprises increased demand for labor. The major difficulty is to recruit skilled workers. The ordinary workers are highly mobile. This causes the difficulty to the production and operation of enterprise. Labor shortages make the price of labor increased. At the same time, this may speed up workers mobility. Rising labor costs have had a great impact for the export-oriented processing SMEs of Zhejiang Province that are low-tech, not core technology, relying on cheap labor (Jian Ping Zhao 2006).

Many export-oriented processing SMEs of Zhejiang mainly depend on the products of labor-intensive and resource-intensive, they are in the lower end of the value chain. The core technology is generally controlled by foreign buyers. They are lack of resources and capital. In particular, the government financial policies conducive to the large State-owned enterprises at present.

If the SMEs in Zhejiang want to win a long-term export advantages, the transformation and upgrading of the SMEs is the fundamental way.

5 The Advantages and Disadvantages of Zhejiang's Export-Oriented Processing SMEs

5.1 The Advantage

The scale of the export-oriented processing SMEs of Zhejiang is often small. This kind of industrial structure makes the managers have capable of assessing the situation and adjusting the industrial structure. A large number of the SMEs can use all kinds of dynamic comparative advantage. In the labor-intensive industries such as textile, clothing, toys and others, they are expanding the wide range of low-cost competitive advantage. The entrepreneurs have the technical ability of imitation to grasp the market. The entrepreneurs of the SMEs can judge the market trends and quickly make investment decisions.

5.2 The Disadvantages

From the position in the global value chain, Zhejiang export-oriented processing SMEs have the following disadvantages.

Many SMEs lack independent brands. In a survey there are only 10 % export enterprises have their own-brand. Most enterprises also belong to the OEM (Original Equipment Manufacturer). With the corresponding, export volume of 76.7 % of SMEs is more than 50 %. This indicates although many enterprises are mainly export-oriented, but the most products are non-independent export brands. Once the raw material prices and labor costs increase, the foreign brands enterprises and the dealer are not corresponding increase in price, the survival of the SMEs will face challenges.

The technology of Zhejiang export-oriented processing SMEs is in the low level. The innovation is not enough. The Product Structure is single. There are low technological contents in the production process. Therefore enterprises lack of competitiveness. At the same time, excessive competition within the industry causes low profit margin. With the increasing prices of hydropower, oil, transportation, labor, land and other production factors, production costs are increased, the export-oriented processing SMEs of Zhejiang are facing serious challenge of resource constraints. They are in the period of rising costs, so that the low-cost competitive advantages are weakened, or even lost. Because of funding, capacity and human resources factors, the export-oriented processing SMEs of Zhejiang are generally rely on the domestic or foreign intermediaries. If they lose their brokers orders, they will easily fall into trouble (Shunsheng Qi 2001).

6 The Factorsaffeting the Transformation of SMEs

According to the global value chain theories, the main factors that have an impact on the transformation of export-oriented processing SMEs are as follows (Jing Huang and Sangen Yang 2006; Jun Hu et al. 2005; Jiajia He 2008):

6.1 The Research and Development Factor

R&D is an important value-generating link. The indicators used to measure R&D capabilities include high-tech equipment, technical staff, the accumulation of technical expertise, investment into technical expertise and innovation in techniques.

6.2 The Production Factor

Production capacity can be measured with such indicators as equipment, production management, supply management, quality control.

6.3 The Marketing Factor

The whole process ranges from the sales, brand management and after-sale service. The marketing capacity of a business can be measured with such indicators as marketing management, sales channels, marketing staff, brand operation, after-sale services.

6.4 The Supportive Activities Factor

The indicators for assessing supportive activities in a company are as follows: infrastructure, resources (capital, labor, and materials), business management (finances, planning, human resources and logistics).

In order to measure the extent of the influence that the R&D, marketing, production and supportive activities factors exert on the transformation of SMEs, this paper adopts an EVA (Economic Value Added) corporate value assessment method. In accordance with the conception of EVA, the assessment formula is as follows:

EVA = Net profit after tax − total capital cost
Worth of the enterprise = investment volume + expected EVA worth

T is defined as the degree of success of enterprise transformation, V_1 represents the net worth of the enterprise before transformation, and V_2 represents the net worth of the enterprise after transformation. Depending on the relative value of the variables, the formula of influence factors can have to three results:

If $V_2 - V_1 > 0, T = (V_2 - V_1)/|V_1| * 100\ \%$ (suppose V_1 never equals 0) is the measure of success in transformation.

When $V_2 - V_1 < 0$, $T < 0$, transformation leads to a negative return in corporate value, and transformation fails.
When $V_2 - V_1 = 0$, $T = 0$, transformation exerts no influence on the enterprise

Therefore an assessment of the influence of each individual factor can be made as well, which only requires defining V_1 and V_2 as the worth of a single influence factor before and after transformation. And calculation methods are the same as shown above.

7 The Transformation Mode of the Export-Oriented Processing SMEs

Based on the global value chain theories and the abovementioned analysis of the influence factors of the SMEs, this paper argues that enterprise transformation mode shifts as enterprise shift their focus among the three basic activities in the global value chain, namely, R&D, production, marketing and supportive activities. And this paper further argues that the main thrust of the transformation goes from OEM to ODM (Original Design Manufacturer), further on to OBM (Original Brand Manufacturer) (Please see to Fig. 1) (Yue Pan 2002; Ye Li and Chuanzhao Li 2004).

7.1 Mode 1: OEM Mode of Continuous Improvement and Competitive Strengths Retaining

This mode suits the companies that are still in their startup stage and are weak in R&D and marketing, thus pursuing a catching-up strategy. With this mode, SMEs can make use of low labor costs combined with the strengths of foreign companies in technology, financing and marketing and engage in processing, assembling, production and export of whole products and spare parts. It is a mode with which companies can gradually accumulate capital and core technical competitiveness.

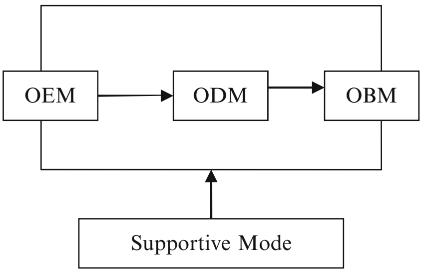

Fig. 1 Business restructuring modes framework

7.2 Mode 2: Transitioning from OEM to ODM

With the accumulation of capital and technical competitiveness, SMEs can shift their focus to the production and export of medium products and whole products and provide services ranging from R&D, manufacturing and after-sale services. In this stage, companies can design their own products, tailor their products to meet the needs of the markets, adopt the competitive strategy of differentiation, and move up the global value chain.

7.3 Mode 3: Transition to OBM from OEM or ODM

This mode requires selling products of self-owned brands at home and abroad and suits the companies already in the maturity stage of their development that have strong R&D and marketing capabilities with enough competence to cultivate and nurture a credible brand. This is a high-level transformation mode.

7.4 Mode 4: Supportive Mode

Ensuring the free flow of production factors and strengthening management within the enterprise. This mode applies throughout all transformation modes and plays a fundamental supportive role.

8 Conclusions

The transformation and upgrading mode that an enterprise adopts should be determined by the development stage and current capacity of the company. This paper incorporates some features of the research into enterprise transformation path and put forth transformation models as follows (Zhi Cui et al. 2006):

In the startup phase, the core competitiveness of an enterprise has not fully taken shape. In order for the enterprise to grow smoothly, transformation mode 1 should be adopted as a way of accumulating capital and cultivating technical capacities. In the growth phase, some capital and other resources have been accumulated and transformation can shift gradually from mode 1 to mode 2, focusing on enhancing R&D capabilities. In the mature phase, an enterprise has already gained its core competitiveness, accumulated enough resources and R&D capabilities and therefore a transition towards mode 3 can take place. And a premium should be placed on setting up sales networks and brand building.

According to the analysis on the reforming influence factors analysis and transformation model framework, at the same time we based on the global value chain theory, this article made the following recommendations:

Strengthening production management and improving production quality, therefore, the enterprises need to continuously improve the production environment, production process, introduce the advanced production equipment, raise the utilization rate of resources, implement the quality control system, and reduce the production cost.

Enhance the R&D capability, therefore, the enterprises need to increase the capital support on the technical investment, ongoing the personnel training, and absorb the industry leader experience, improve their own innovation level.

Expanding marketing channels, building their own brand, therefore, enterprises need to expand their marketing channels through trade exhibition, e-commerce platform, enterprises mutually beneficial cooperation and so on. Enterprises need to develop international market. Enterprises should gradually establish independent brand, pay attention to after-sales service, and gradually improve service system.

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The Model of Regional Innovation System Based on the Complex Adaptive System

Wen-Liang Sun, Zi-Biao Li, and Bao-Min Hu

Abstract As a complex adaptive system (CAS) itself, the regional innovation system (RIS) is, whether in terms of features, operating mode or evolution, in line with the essential requirement of the CAS. Based on the CAS theory, the analysis and study on the RIS can not only shed light upon the nature of the RIS but help to better build and improve the system, so that the RIS can play a leading role in supporting a sustained regional economic development. From the perspective of CAS, this paper analyzes the complex adaptive features of the RIS and then introduces a RIS model based on the CAS theory, which in turn proves that it is of significant theoretical and practical importance to study the RIS in light of the CAS theory.

Keywords Adaptive agent • Complex adaptive system (CAS) • Flow • Regional innovation system (RIS)

1 Introduction

The concept of regional innovation system (RIS) was first proposed in the 1990s, and it has since become a research focus in the academic circle. Although great progress has been made on the research of it, it is apparent that most of the researches are qualitative, which mainly focuses on the framework, different branches of elements and functional characteristics of the RIS, while the number of researches on a systematic and quantitative basis is relatively small and what should also be noted is that no one in China has ever carried out such researches in light of the complex adaptive system (CAS). The RIS, which is gradually formed in

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a self-organized manner, turns out to be a rather complex adaptive system. Through the interactions between different agents, it gives birth to various kinds of innovation activities that can meet the social demand. Therefore, it is of significant importance for us to apply the CAS principle when carrying out researches on the RIS.

2 Complex Adaptive System (CAS)

The concept of CAS was formally proposed by John Holland in 1994, and since then it has been attracting more and more interest from the international academic arena. The basic idea of CAS lies in the "agent"—each active and adaptive individual or single element with its own objective and initiative. The agent can learn and accumulate experience while constantly interacting with the environment or other agents and adjust its structure and behavior based on such experience, so it is justifiable to say that it is such a process that constitutes the major driving force for the development and evolution of the system.

2.1 Adaptive Agent

According to the basic idea of the CAS theory, the complexity of the CAS derives from the adaptability of the agent (Jinluan Ren and Peiliang Gu 2002). There exist a large amount of active and adaptive agents in the CAS, and with adaptability, a certain agent can have a better understanding of the effects of their behavior and then make adjustments to their behavior rule accordingly so that they can have stronger survivability in the objective environment. Even though all the agents coexist in the common environment of CAS, due to their different objectives, internal structures as well as survivability, they are simultaneously conducting a parallel and independent adaptive learning and evolution in accordance with the relatively small surrounding environment.

2.2 Features of the CAS

Major features of the CAS theory lies in the initiative endowed to the agents. With a view that complex behaviors of the whole system derive from the interactions between different agents, great initiative is endowed to the agents, thus behaviors at both the microscopic level and the macroscopic level are naturally connected (Holland 2001). As the driving force of the development and evolution of the system, interactions between different agents and between agents and the environment can not only bring forth the system's integrity but enable each agent to learn from such experience and adjust its structure and behavior so as to have stronger survivability in the objective environment. In a word, the core idea of the CAS theory is “adaptability gives birth to complexity”.

3 Complex Adaptability of the RIS

The RIS has a complex adaptive property, as can be seen from the following:

- Adaptive agent. As the fundamental concept in the CAS theory, adaptive agents in the RIS are such as enterprises, regional governments, intermediary organizations, research institutions as well as institutions of higher education. They can constantly improve their decision behavior in light of the changing situation and forecast of the future to better adapt themselves to the requirement of the system and the changing situation. Such kind of adaptation is subjective and creative, and it is just such adaptation that contributes to the complexity of the RIS.
- Cluster. In RIS, clustering phenomena can be manifested in various forms, such as cooperative group and dynamic alliance formed in the innovation course of the innovation subjects, industrial bunch of group formed in the process of the development of local industries, the establishment of high-tech industrial zone, enterprise cooperative innovation, institution merge within the region, etc. Moreover, examples like university merging and cooperation between enterprises and research institution of universities in the course of knowledge creation and flowing can all be counted as clustering phenomena.
- Nonlinearity. In the RIS, interactions between different agents will bring forth various kinds of complex nonlinear characteristics. For example, an enterprise’s technological innovation behavior may be under the influence of many different factors including the history and present situation of the enterprise, capital, conditions of main rivals, national policy and the market condition. Additionally, nonlinear characteristics can also be found in such aspects as the complicated relations between different agents, the interactions between different adaptive agents in the RIS and the integration of the system.
- Flow. In the RIS, the flow of information, knowledge, material and energy among different agents is happening all the time, and without such flow the communication and cooperation between different innovation agents and between the system and the external environment could not be possible, nor could there be a system. Therefore, an unblocked flow is of significant importance to the development and evolution of the system.
- Diversity. In light of the CAS theory, diversity means that while different agents are adapting themselves to the environment the subtle difference between them will become more and more obvious, thus resulting in differentiation. With the development of regional technology and economy, the RIS boosts a large number of different enterprises and agents, and the interactions between those different agents provide constant stimulus for the development of the system.

- Internal model and building blocks. Each agent in the RIS serves as an independent system and has its own model. These sub-systems can also be regarded as the RIS' internal models due to their dynamic role and ability to make predictions about the future. Hence, it is justifiable to say that it seems as if the RIS were formed through changing the combination mode of different agents or different sub-systems. In such a sense, the combination mode of these blocks is the essential cause for the system's complexity.

Based on the analysis above, we can conclude that the innovation system is undeniably part of the CAS, so it is necessary and practical for us to study the innovation theory from the perspective of the CAS theory.

4 Analyzing RIS with CAS

At the request of CAS, RIS is supposed to encompass such aspects as the agent, agent resources, agent knowledge base, interactions among agents as well as interactions between the agent and the environment. In this sense, RIS is an open local area network composed of the above aspects (Townsend 2003). When we set the enterprises, government, universities, scientific research institutions and intermediaries as the agents, which we further denote as A, while at the same time we denote agent resources as R, agent knowledge base as K, the interactions among agents of RIS as TI, and the interactions between the agent and the environment as TO, we can thus put RIS the following way:

$$\mathrm{RIS} = \{\mathrm{A}, \mathrm{R}, \mathrm{K}, \mathrm{TI}, \mathrm{TO}\} \tag{1}$$

In the meantime, by referring to biological theory, the RIS structure can be expressed as genetic models. When the enterprises, government, universities, scientific research institutions and intermediaries are denoted as A_1, A_2, A_3, A_4, A_5 respectively, RIS resembles a chromosome with a length at 5: $A = < A_1, A_2, A_3, A_4, A_5 >$. Meanwhile, a series of allelomorphs resides in the gene at i position ($A_i = \{a_{i1}, a_{i2}, \cdots, a_{ik_i}\}$, $i = 1, 2, \cdots, 5$; k_i means the number of allelomorphs at i position). In RIS, all agents are likely to interrelate and interact with each other. Therefore, the structure space of RIS can be put the following way:

$$\Omega = A_1 \times A_2 \times A_3 \times A_4 \times A_5 = \prod_{i=1}^{5} A_i \tag{2}$$

Ω refers to the maximum space of possible RIS composition.

The generation mechanism of RIS' complexity is what drives forward its own continued evolution. In the light of the idea that "adaptability gives birth to complexity", it is known to us that inside the RIS, "complexity" mainly refers to the adaptation to the development of the agent itself and the interactions among agents (Rennings 2000).

5 Adaptive Model of RIS

As an open system, RIS exchanges substances, energy and information with the outside world. Meanwhile, its instability provides room for its own evolution.

According to the idea that “adaptability gives birth to complexity”, the complexity of RIS is rooted in its own development and evolution, and takes shape along the process that combines the adaptation among various agents in RIS and the agents’ adaptation to the outside world (Fleming and Sorenson 2001). It usually takes on different meanings for different physical systems to adapt to the outside world. For instance, the adaptability of biological system manifests itself in its survivability in particular environments; economic system in its social utility, artificial intelligence system in the effectiveness of its reasoning process and conclusion, etc. In this sense, the adaptability of RIS is manifested as the interactions and co-adaptations among its agents as well as its adjustment to regional economic growth, or, in other words, its ability to support and guide the sustained and sound development of regional economy.

Apart from adjusting itself to regional economic growth, RIS in the meanwhile also exchanges resources and information with regional economic system (Doloreux and Parto 2005). Moreover, it is of great importance for RIS to interact with other relevant innovation systems, national innovation systems, foreign enterprises and other economic subjects. It is also inextricably linked with such external conditions as regional policies, humanistic condition, infrastructure and market, etc.

Therefore, based on the model system that describes adaptive process put forward by Holland, we can give an account of the adaptive process of RIS in regional economic growth and then propose an adaptive model for RIS based on its complex adaptability. The model is as Fig. 1.

The adaptive model discloses the operational mode of RIS in a proper fashion (Anderson 1999). We can see from the model that RIS is at the service of regional economic growth so as to support and guide the sound and sustained growth of regional economy. Apart from adapting to each other, the agents in RIS exchange

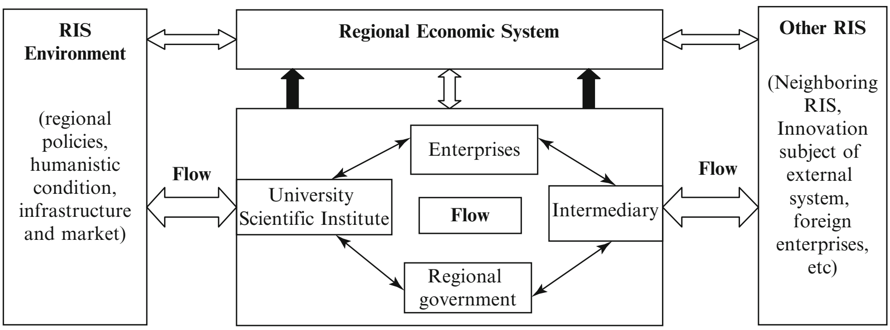

Fig. 1 Adaptive model for RIS

substances and energy with the outside world. There are two factors exerting significant influences on the complex adaptability of RIS: interactions among the agents and the co-adaptation between RIS and the outside world. Only when RIS meets the demand of the adaptability of regional economy can the regional economic development be sustained and drove forward (Carlsson et al. 2002). Here, "adaptability" means complex adaptability in particular, instead of adaptability in a general sense (Ting-Lin Lee and Nick von Tunzelmann 2005).

6 Conclusion

From the above study we can see that as a complex adaptive system, the features, operating mode and evolution of the RIS are in conformity with the basic requirement of the CAS. The analysis and study of the RIS with CAS-related theories can not only shed light upon the nature of RIS, but also enables us to build and improve RIS and give full play to its role to back up and guide the sustained growth of regional economy. Therefore, it is of great theoretical and practical significance to study RIS from the perspective of the CAS.

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User Transfer in Collaborative Commerce: Evident from Virtual Community to Social Commerce

Guo-yin Jiang, Fei-cheng Ma, Yun-zhou Fang, and Xiu-zhen Li

Abstract In China, social commerce provided by virtual community is a classic mode of collaborative commerce. The current research analyzes what factors affect transferring virtual community member to consumer of social commerce provided by virtual community. We propose and empirically test a model of user transfer mechanism. The findings indicate that attitude to virtual community can be transferred to social commerce provided by virtual community, the perceived fit of brand and technology have effect on attitude to social commerce. This study also finds that, subjective norms positively influences perceiving to brand and technology, and attitude to social commerce, user involvement can enhance social influence of social commerce and user' attitude to social commerce. This research advances our understanding of the user transfer from virtual community to social commerce and provides insights into the marketing promotion strategies for social commerce.

Keywords Collaborative commerce • Perceived brand fit • Perceived technology fit • User involvement • User transfer

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1 Introduction

With the development of e-commerce in China, collaborative commerce is a main trend of network economy (Jiang et al. 2012). The social commerce is a classic collaborative commerce. Many portals which once provided network community services in China to internet users, and then enhance their services by launching online shopping platform or providing transaction function to the existing website, while many purchasing websites which once provide transaction services are providing network community services. According to CNNIC (China Internet Network Information Center), in China, the number of people who use social network reaches to 242 million by the end of 2012 (China Internet Network Information Center 2013), those who will be potential consumers of social commerce.

The virtual community appeals to a large number of network users by its openness, interactivity and the ability to connect users with similar interests, which makes it easier for the virtual community carrying out its targeted marketing campaigns. Network community and transaction can be mutually promoted, which is called collaboration, its entire effect will be greater than the sum of the independent entities (Camarinha-Matos et al. 2009), or even produce synergy value (Jiang and Deng 2011).

Even so, not all the members from the network communities turn out to be the online consumers. That is to say, no matter the e-commerce platform provider, search engine provider, and portals, even they launch the network communities or shopping websites, no one can ensure the success. For an instance, Youa, a C2C platform established in 2008 by Baidu, the largest Chinese search engine provider, but ends in failure in 2011, though it is once regarded as the example of seamless combination of network community and online trade. Therefore, how to convert the network community user to the online buyer is a crucial issue for the practicer.

In research area, though online community and online transaction attracting many researchers focusing on the changes in this field, there is still little research directly to discuss the mechanism of user transfer from network community to purchase platform.

In this paper, we build empirical model to analysis how factors affect attitude toward user transfer. There are literatures to study user transfer from diversity perspective. Lu et al. (2010) empirically research on trust in Taobao' virtual communities and its effect on consumers' purchase intention, evident test how convert members of their virtual communities (VCs) into C2C buyers and sellers. Lu et al. (2011) have study transfer usage from the offline to the online channel. Song et al. (2010) build brand transfer model to demonstrate usage behavior between network product/service sharing the same brand and provides insights into the marketing promotion strategies for network products in electronic markets evident using Baidu. Song et al. (2011) have done empirical research product integration on online advertising effectiveness, and Usage-Transfer behavior between Non-Substitutable Technologies by using evident from instant messenger and portal (Song et al. 2009).

With consideration of the characteristics of network community and e-commerce in China, this research proposes the user conversion model, which is based on the related studies. In our research, the attitude to use the synergy service is regarded as the main indicator to predict and explain the user conversion behavior.

Besides discussing the effects of the three factors (Attitude to the Parent Brand, User Involvement and Subjective Norms, which were proposed in related literatures) on the attitude to use, two new variables (Perceived Brand Fit and Perceived Technology Fit) affecting synergy service conversion are defined and verified in our study.

2 Research Model and Hypotheses

Based on previous literatures, we build empirical model to analysis how factors can affect attitude of consumer, see Fig. 1. The factors can include brand, technology, subjective norms and users Involvement and others.

Generally, user's attitude toward parent brand has positive effect on attitude to child brand, that is attitude transfer (Song et al. 2010). The attitude to virtual community (ATTA) will have effect on attitude to social commerce provided by virtual community (ATU), perceived technology fit (PTF) and perceived brand fit (PBF) between parent brand and child brand.

Collaborative commerce is a child brand which is the result of parent brand to extend it's product or service, the brand fit will affect brand recognition of consumer, perceived brand fit has a positive effect on attitude to the collaborative (Aaker and Keller 1990). To avoid or reduce the uncertainty and perceived risk associated with the newly products or services, firms often exploit consumers' recognition of the existed brands to facilitate the entrance of the new markets (Song et al. 2010). Same as brand fit, technology fit is a measure variable to observe similarity between brand product and extension product, the higher similarity can facilitate use of

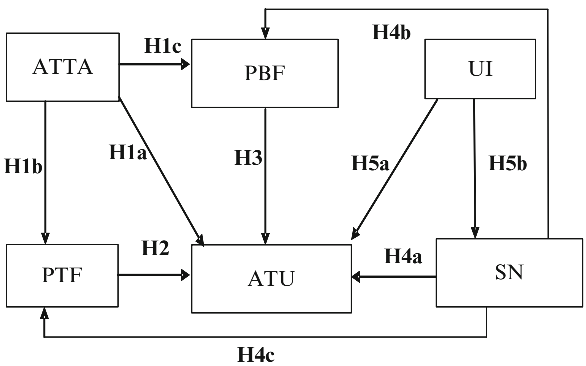

Fig. 1 Research mode

consumer. Generally, subjective norm (SN) (Fishbein and Ajzen 1975) measure effect of social or work environment on user' attitude. In work, using collaborative product is a trend, friend and relative can recommend use of collaborative product (Ajzen 2002).

The user involvement (UI) is as the psychological state which is the importance and personal relevance that users attach to a given product or service (Santosa et al. 2005), user involvement can be measured by using variables include Essential, Trivial, Significant, Important, and needed of service.

3 Methodology

We next firstly explain methods to collect data, and then we describe the process of data analysis.

3.1 Data Collection

An offline survey, targeted at social commerce users, was conducted. The respondents could fill in a questionnaire regarding their opinions on Tianya shopping provided by Tianya, which is one of the biggest virtual communities. In order to attract more respondents to participate in this survey, a little present was offered. The data was collected over 3 weeks. After discarding responses with incomplete data and inconsistent demographic information, we collected 248 valid responses, which gave us 400, the responding rate is 62 %.

3.2 Data Analysis

We first examine our measurement model and then test our hypotheses by using Amos 8 and SPSS 16.0. Reliability refers to the reliability of scales, including stability and consistency, Cronbach's alpha is 0.85, over 0.8, meaning reliability is accepted in social science research (Fornell and Larcker 1981), KMO is 0.879, each KMO is over 0.6, meaning samples are validity (Gefen et al. 2000), and the model fitting was satisfactory, All hypothesized paths in the research model were found to be statistically significant, see Table 1 ($|CR| \geq 1.96$, $P \leq 0.05$). The result of statistical and analysis of structure model is shown in Fig. 2.

According to the results, the testing output of hypothesis previously proposed is shown in Table 1.

Table 1 Results of hypotheses testing

Hypotheses	Content of hypotheses	Supported (Yes/No)
H1a	Attitude to the virtual community positively affect attitude to use	Yes
H1b	Attitude to the virtual community positively affect perceived technology fit	Yes
H1c	Attitude to the virtual community positively affect perceived brand fit	Yes
H2	Perceived technology fit positively affect attitude to social commerce	Yes
H3	Perceived brand fit positively affect attitude to social commerce	Yes
H4a	Subjective norms positively affect attitude to use	Yes
H4b	Subjective norms positively affect perceived brand fit	Yes
H4c	Subjective norms positively affect perceived technology fit	Yes
H5a	User involvement positively affect attitude to social commerce	Yes
H5b	User involvement positively affect subjective norms	Yes

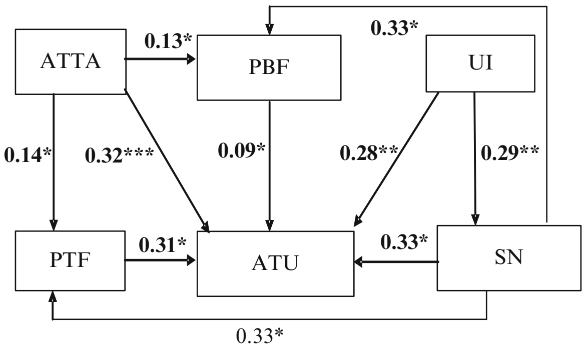

Fig. 2 Standardized Amos solution (model with only significant paths) (Note: $*p < 0.05$; $**p < 0.01$; $***p < 0.001$)

4 Conclusions

Collaborative commerce is a trend of e-commerce, such as community commerce, which is an e-commerce provided by virtue community. In this paper, we provide a empirical model to explore what and how factors effect on attitude to collaborative commerce.

The results generally support the hypotheses, indicating that attitude to the virtual community has significant effect on attitude to social commerce, that is imagined to parent brand or service can be transferred to child brand or service. It also verify famous brand can easy or will to develop new child brand or service.

Brand and technology fit have effect on attitude to social brand, it demonstrate personal experience can result first felling to social commerce, these feeling affected by social norm, i.e. recommended by friends, relatives, and colleagues have significant effect on perceived brand fit and perceived technology fit. So, marketing by word of mouth is important for populating new extended brand.

User involvements have significant effect on social norm and user' attitude to social commerce, effective interactive marking activities are key to social word of mouth, and also directly affect user pay attention to social commerce.

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The Exploration and Study of Innovation Pattern of Community Administration: A Case Study of Shenzhen

Bo-lin Xie

Abstract With the rapid development of social economy and the expansion of city, the construction of new city and new community has changed quickly. There are also deep change in the structure of city and community. Community, as the base part of the city, is very important to the development of the city. The question and administrative work in a community has been taken seriously by the government, and has also been one of the research focus in academy. The study takes the pattern of community administration in Shenzhen as the object of the study, analysing the problems remaining in the community administration of Shenzhen. Synthesizing the knowledge of multidisciplinary, the study proposes a new pattern of community administration, and raises systematic resolution for solving the remaining problems in community administration.

Keywords Community management • Innovation model • Shenzhen

1 Introduction

The theory and practice of community was born and developed in the West. In 1881, the concept of community was first put forward by a Germany socialist, F. Tolmies. Tolmies suggested that, Gemeinschaft (translated as community now) is made up by groups of people who has the same value orientation. They have close relationship, always helping each other, and they participate in the community because they are born and grow up there (Tönnies 1887). David Popenoe said that community is a group of people organized because of daily contact in a certain area (Popenoe 1973). R. E Parker believed that community is people lived in a restricted area.

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The development of the western study of community follows two direction: one with the differentiation of sociology, the study of community has become more and more specialization, and has formed many theories, mainly including Humanities location theory, Social systems theory and Social interaction theory. The other with the reinforce of applicability, there has been more research on urban planning, community development and social work, which has also played an important role in the Decision-making of the Government (Shouhong Xie and Shuangxi Xie 2004).

2 The Survey and Statistic Analysis of the Remaining Problems in Shenzhen Community

2.1 The Remaining Problems in Shenzhen Community

Shenzhen is a burgeoning city with high level of market and openness, whose economic aggregate has been the front row in China. Although the development of the city community has only last less than 20 years, it has possessed a series of features. The community problems of Shenzhen involve many departments governed by governments at all levels, such as economy, construction, urban management, city administration, population, public security, culture (Jie Zeng 2001). Community is the object of work and service of these departments. The study of problems involved in Shenzhen community is multi-dimensioned and abundant.

As influenced by a series of factors such as economy and geography, the community in Shenzhen consists of the following characteristics.

The inverted pyramid structure of community population: as the fastest development and biggest migration city of the world in the second in the twentieth century, Shenzhen owns a typical characteristic of migration city. As a result, the floating population must be taken seriously when study community problems or any other social problems in this city dominated by floating population.

Diversification of the community form: the fast development of economy and burgeoning industry has made the community present a feature of diversification. Community is divided into administrative community and functional community, and its characteristics and rules are discussed through two different angles.

The rapid development of urbanization: These characteristics make the coexistence of harmony and non-harmony of the community and its whole living city environment.

2.2 The Sample Frame of Respondents

The author use on-site survey as the method of this study. The response rate is extremely high (up to 100 %) all of the 300 questionnaires were equally issued to

Table 1 The condition of the questionnaires' issuing and recovery

Issued questionnaires (copies)	Recovered questionnaire (copies)	Recovery rate (%)	Valid questionnaires (copies)	Valid response rate (%)
300	300	100	224	74.67

Table 2 The frame of the valid questionnaire

Variable	Category	Samples	Rate (%)
Sex	Male	115	51.34
	Female	109	48.66
Age	Under 18	14	6.25
	18–30	125	55.80
	31–40	67	29.91
	41–50	16	7.14
	Over 50	2	0.89
Education background	High school or below	14	6.25
	Junior college	43	19.20
	Undergraduate	118	52.68
	Graduate or above	49	21.88
Income	Under 1,000 yuan	22	9.82
	1,000–3,000	125	55.80
	3,000–5,000	59	26.33
	Over 5,000 yuan	18	8.04

the six district in Shenzhen, each district with 50 copies. Taken the respondents own subjective feelings and characteristics into consideration, there may be some deviations in filling the questionnaires. As a result, the author took preliminary examination of the questionnaires, and screens 224 valid copies. The valid response rate is 74.67. Shown as Table 1.

The statistical result is shown as Table 2.

3 The Factor Analysis of the Remaining Question in Shenzhen Community

Factor analysis, one branch of the multivariate statistics, uses several factors to describe the relationship of many indicators and to imply the most information from the original documents (Harman 1960; Kline 1994). Through the correlation analysis of the variances, variances which are strongly connected are classified into the same category, and one series of variances are called a factor (which is a hypothetical variance). In fact, it is a method to reduce the high-dimensional variance. As is known form the previous chapter, there exist many problems in the community administration, which makes that there is much information to investigate. This chapter adopts the factor analysis to simplify plenty of problems into several main problems.

Table 3 Analysis of total square deviation table

	Initial eigenvalues		
Component	Total	% of variance	Cumulative %
1	1.848	26.161	26.161
2	1.704	25.681	51.842
3	1.67	35.566	86.408
4	1.507	5.023	88.35
5	1.479	4.93	89.35
6	1.396	4.655	92.76
7	1.386	4.622	100
	Extraction sums of squared loadings		
Component	Total	% of variance	Cumulative %
1	1.848	26.161	26.161
2	1.704	25.681	51.842
3	1.67	35.566	86.408
4			
5			
6			
7			

3.1 Factor Analysis of the Community Board's Remaining Problems

Based on the factor analysis of the questionnaires of the Community Board's remaining problems, the results are shown as Table 3.

3.1.1 Extraction Method: Principal Component Analysis

As can be seen from Table 3, the problems of Community Board can be extracted into three common factors. The accumulative contribution rate of the three common factors is up to 86.408 %. The fist common factor has high loading on the first, the forth and the fifth problems, which means that the function orientation of the Community Board has some shortcomings. The second common factor has high loadings on the first, the fourth and the sixth problems, which means there are serious problems of the administrative staff's quality.

3.2 Factor Analysis of the Owner Committee's Remaining Problems

Based on the factor analysis of the questionnaires of the owner committee's remaining problems, the results are shown as Table 4.

Table 4 Analysis of total square deviation table

	Initial eigenvalues		
Component	Total	% of variance	Cumulative %
1	1.289	4.298	40.935
2	1.203	24.008	64.943
3	1.144	23.812	68.755
4	1.107	3.69	75.446
5	1.087	3.624	86.069
6	1.027	3.425	100
7	1.289	4.298	40.935
	Extraction sums of squared loadings		
Component	Total	% of variance	Cumulative %
1	1.289	4.298	40.935
2	1.203	24.008	64.943
3	1.144	23.812	68.755
4			
5			
6			
7			

As can be seen from Table 4, the problems of owner committee can be extracted into three common factors. The accumulative contribution rate of the three common factors is up to 68.755 %. The fist common factor has high loading on the second and the third problems, which means that the organization structure of the Owner committee has some shortcomings. The second common factor has high loadings on the fourth and the sixth problems, which means there are serious problems of the Owner committee when performing their function.

3.3 Factor Analysis of the Property Management Company's Remaining Problems

Based on the factor analysis of the questionnaires of the property management company's remaining problems, the results are shown as Table 5.

As can be seen from Table 5, the problems of property management company can be extracted into two common factors. With its accumulative contribution rate being up to 33.425 %, the fist common factor has high loading on the third, the fourth and the seventh problems, which means that the function orientation of the Property management company has some shortcomings. With its accumulative contribution rate being up to 63.749 %, the second common factor has high loadings on the first and the sixth problems, which means there are problems of the Property management company's management system.

Table 5 Analysis of total square deviation table

Component	Initial eigenvalues		
	Total	% of variance	Cumulative %
1	4.027	33.425	40.935
2	0.976	33.255	64.943
3	0.931	3.104	68.755
4	0.912	3.04	75.446
5	0.891	2.972	86.069
6	0.841	2.804	100
7	0.829	2.762	40.935
	Extraction sums of squared loadings		
Component	Total	% of variance	Cumulative %
1	4.027	33.425	33.425
2	63.749	63.749	63.749
3			
4			
5			
6			
7			

Table 6 Analysis of total square deviation table

Component	Initial eigenvalues		
	Total	% of variance	Cumulative %
1	1.732	52.441	52.441
2	0.712	32.375	84.851
3	0.687	2.29	87.141
4	0.673	2.243	89.384
5	0.638	2.127	91.511
6	0.605	2.016	100
7	1.732	52.441	52.441
	Extraction sums of squared loadings		
Component	Total	% of variance	Cumulative %
1	1.732	52.441	52.441
2	0.712	32.375	84.851
3			
4			
5			
6			
7			

3.4 *Factor Analysis of the Public Facilities' Remaining Problems*

Based on the factor analysis of the questionnaires of the public facilities' remaining problems, the results are shown as Table 6.

As can be seen from Table 6, the problems of public facilities can be extracted into two common factors. With its accumulative contribution rate being up to

Table 7 Analysis of total square deviation table

	Initial eigenvalues		
Component	Total	% of variance	Cumulative %
1	1.547	32.823	32.823
2	1.501	41.67	73.02
3	0.461	1.538	78.558
4	0.433	1.442	75,034
5	0.638	2.127	91.511
6	0.605	2.016	100
7	1.547	32.823	32.823
	Extraction sums of squared loadings		
Component	Total	% of variance	Cumulative %
1	1.547	32.823	32.823
2	1.501	41.67	73.02
3			
4			
5			
6			
7			

52.441 %, the fist common factor has high loading on the second and the third problems, which means that the management system of the Public facilities has some shortcomings. With its accumulative contribution rate being up to 84.851 %, the second common factor has high loadings on the first, the fourth and the sixth problems, which means there are problems of the Public facilities' staff quality.

3.5 Factor Analysis of the Community Member's Remaining Problems

Based on the factor analysis of the questionnaires of the community members' remaining problems, the results are shown as Table 7.

As can be seen from Table 7, the problems of community members can be extracted into two common factors. With its accumulative contribution rate being up to 32.823 %, the fist common factor has high loading on the first and the fourth problems, which means that the community members lack the consciousness of legal. With its accumulative contribution rate being up to 63.749 %, the second common factor has high loadings on the three and the sixth problems, which means there are problems of the Community members' inspection.

As can be seen from the analysis, the power of the community management system is over decentralized. The community board, the owner committee, the neighborhood committee, the property management company and the public facilities all have the problems of unclear functional orientation, among which, the owner committee is the worst. It does not perform its due duty, which leads to the phenomenon of 'small owners and majordomo'.

4 The Innovation Pattern of Shenzhen's Community Management

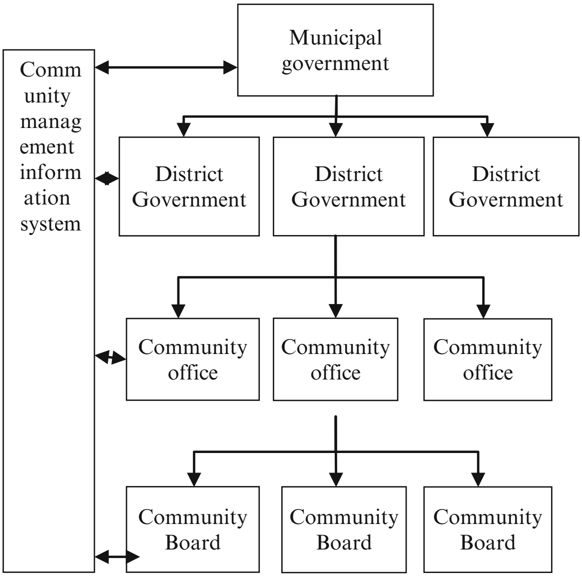
The linear pattern of administrative system, under planned economy, cannot perform effective management on community resources and achieve the benefits of all parts of the community management (Jun Fang 2003). At present, Ministry of Civil Affairs advocates the management system of 'two levels of government, three levels of management and four levels of network'. Three levels of management means the city's, the district's (county) and the sub-district office's management of the local affairs. The four levels of network is the city, the district (county), the sub-district office and the neighborhood committee. It emphasizes the fact that power should be delegated form the city and district to the street, and establish the community management system (Zhilun Wu 2004). Although compared to the linear pattern of administrative system under planned economy, this kind of community management system has some advantages. It also has some kind of problems, as when the street becomes the main part of the community management, the government does not really delegate the power to the residents. Meantime, there lack communication and connection between the community management and the body of service, which lead to many problems in the management of the community. As a result, we need to establish an innovation community system based on convenient communication between all parts of community management, perfect legal system, scientific management system, integration of departments and regions at different levels and the autonomy of community residents.

Through the investigation and study of the community management system in Shenzhen, and based on the original system of 'two levels of government, three levels of management', the author proposes an innovation community management system, by changing the sub-district office into community office. Still as an agency of the government, the community office has the administrative function, and it is positioned as the administrative manager of the area, performing its duty. Being elected by the neighborhood committee, besides performing some kind of political affairs, its main function is providing service for residents. The specific service affairs are chosen by the market. To better implement the plan of development, construction and administration by the city and district to the community, several community offices are established at the district to manage the community neighborhood committee, directing and inspecting its work.

Based on the aforementioned analysis, the author constructs an innovation community management system consisting of four levels. Each level has different level of power and clear function, and they are responsible for different level of work. the framework is shown as Fig. 1.

The first level is the Municipal government. It is mainly responsible for the integrated planning and management of the development and construction of community, formulating relative laws, regulations and the policy of community establishment, used as the basis of the community management work.

Fig. 1 The innovation pattern of community management in Shenzhen



The second level is district government. It performs all the function connected to the Municipal government in its jurisdiction area according to the plan, policy and relative regulations of the Municipal government. The district government can establish the community management organization (community office), and is responsible for part of government affairs related to the residents. Through its function department, the district government can direct, inspect and support the management of community.

The third level is community office. Community is established under the district in order to better manage the community and make convenience to the residents. It is mainly responsible for the government affairs such as household registration and security, inspecting the activities of community building, sanitation and residents, and supporting the work of community board.

The fourth level is community board. It is either elected democratically by the community residents, or determined by nominating, noticing and asking for the residents' advice under the direction and assistance of the community office. The community board is established according to the scope of management and the actual situation. It is a Basic Mass Autonomous Organization representing residents' self-management, self-education and self-service. It integrates all kinds of resources from the community and manages all the specific work under the direction and inspection of the community office. Based on the information technology, the community office can establish the community information management system, and release the management information of all the levels of community management. Meantime, it can establish the system of inspection and complains. In this way, the government can inspect the specific situation of implementing the policy or measures, and formulate corresponding policy according to the remaining problems. The residents' complain and advice can be heard via the complains system, thus changing the original one-way management and controlling relationship between government and residents, and realizing the two-way interaction between government and residents. All levels of community management can get the work situation of community management timely, and participate in the mutual inspection of all levels of community management.

5 Countermeasure and Suggestion

5.1 Changing Ideas and Making the Responsibility Clear

Government needs to change the idea of all-round government into limited government, and the idea of administration into residents' autonomy. The construction and development does not only depend on the management of government. It's also a systematic project which needs the joint efforts of all the levels of community management. The government needs to make its own responsibility clear, and turn over the functions belonged to other departments to them, and the rights belonged to residents to themselves (Na Wei 2003).

5.2 Improving the Ability of Management and Legality

Government need to improve the ability of the community management, using measures of administration, economy and legality to guide the behaviors of all levels of community, and makes the work of managing community in good order. Only under the guarantee of law and system, and making all the activities of community management performed under the law, can the residents' interests be protected and the goal of community management be achieved.

5.3 Improving the Ability of Government's Decision-Making in Planning the Development of Community

Community is playing more and more important role in the progress of urbanization, and the management of community is becoming an important part of city management. The work of community management must meet the needs of residents' actual life and the construction of urbanization. Government should propose scientific and reasonable planning for the community development according to the community management of different areas.

5.4 Inspecting All Levels of Community Management Carefully

Government should deal with affairs according to law and enforce the law and regulation carefully in order to protect residents' legitimate interest. By fully using the communication channel of community management information system, the government can know the situation of community management and carry out corresponding measures. The publicity and openness feature of the inspection management can have certain restraint on all levels of community management, and their unlawful infringement acts will be inspected by the residents and got punished by the law (Jianshun Yang 2011).

5.5 Improving Comprehensive Capability of Government Staff

The development of the management of community is strongly connected with the management level of the government, so the government staff have to continuously improve their overall quality, not only equipped with high level of morality, but also with professional theoretical knowledge of community management and related business. The government staff can improve their comprehensive capability either by their own efforts to keep learning, or by participate in the regular training organized by the government in order to enrich their theoretical knowledge and management ability.

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Simulation Modeling for a Container Terminal with Enhanced Information Technology

Rie Gaku

Abstract Information systems have been introduced to accumulate real-time tracking data on containers and transporters at container terminals in ports. Logistics managers of container terminals need an intelligent tool to analyze the performance of highly complex and large logistics systems using of the accumulated real-time tracking data. This paper addresses proposing a procedure of analyzing the performance at a real container terminal, especially by making use of the electronic real-time tracking data that is accumulated from united terminal IMSs (IMS: information management system). To analyze the operations performance, all of the operational activities of an actual container terminal in Japan are simulated. It is found that the information obtained by performing simulation is effective for analyzing the performance of the operation.

Keywords Container terminal • Materials handling • Simulation

1 Introduction

Container terminal operation systems are complex and large and are designed to provide customers with high-quality service. United Terminal IMSs have been introduced to control operations and to accumulate real-time tracking data on containers and transporters at container terminals in ports. There is a potential need for logistics managers to have an intelligent tool, which should be developed to analyze these highly complex and dynamic logistics systems, making use of accumulated real-time tracking data.

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2 Brief Literature Review

There are many studies focused on various issues concerned with container terminals. Several studies have used computer simulation to schedule cargo-handling equipment at container terminals (Kim and Kim 1999; Ng 2005; Guo et al. 2008). The issues of storage and stacking in the planning of ships and container yards can be addressed using simulation, which has been studied in recent years (van Asperen et al. 2010; Dekker et al. 2006; Zeng et al. 2010).

A current review of the literature indicates that few studies have been reported on the modeling of a whole container terminal system with a simulation based approach using electronic real-time tracking data. In this paper, a simulation approach is employed at all of the operations of real container terminals in Nagoya, Japan, specifically at the Nabeta Pier container terminal, to analyze the performance. The procedures of analyzing the operations performance is described, especially by using electronic real-time tracking data accumulated from the United Terminal IMS.

3 Simulation Modeling Steps

This section presents a brief overview of the steps of simulation modeling for materials handling systems of a container terminal.

Figure 1 represents a series of steps for applying simulation to container terminal systems. The first step, *Raw Data Collected from United Terminal IMSs*, helps to acquire a series of raw data, including handling instructions and handling completion information for transfer cranes, straddle careers, and top lifters, inbound vessel information. At Step 2, a series of raw data is processed and input data for simulation is extracted from the processed data based on the operation flows. During the simulation model-building step, system design configurations are developed based on the essential operation flows (i.e. importing process and exporting process). At Step 4, verification and validation of the simulation model is performed to determine whether the simulation model adequately describes the actual system performance. At the last step, simulation experiments are performed to analyze statistical parameters.

4 An Example

4.1 Nabeta Pier Container Terminal

The Nabeta Pier Container Terminal in this study sustains the central Japan economic arena with a focus on multi-frequency small-sum cargo. A general view of the container terminal is shown in Fig. 2. Responding to the increasing amounts

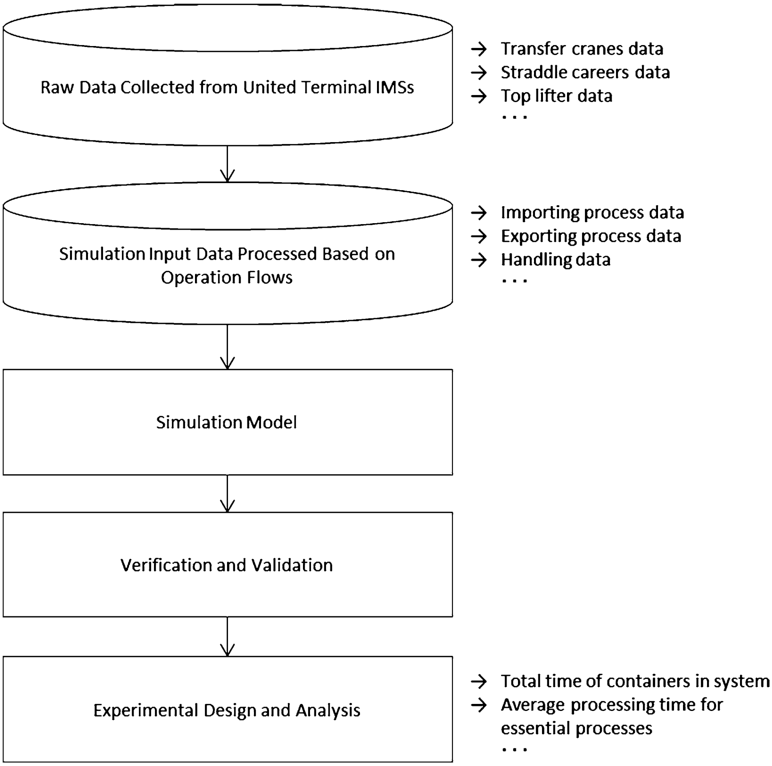


Fig. 1 General simulation modeling steps

Fig. 2 A general view of a container terminal

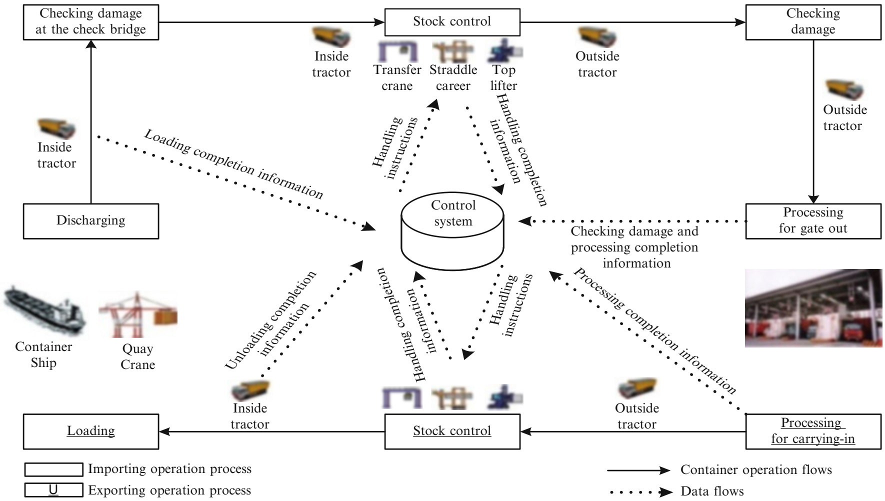


Fig. 3 Container operation flows and data flows in the Nagoya United Terminal IM

of container cargoes, the efficiency of materials handling operations are becoming a vital problem. Although the advanced United Terminal IMS has contributed to tracking the situations of containers and cargo-handling equipments to make operation control easier than before, it is still difficult for logistics managers to resolve the problem of ship inbound and outbound delays which can only be accomplished with real-time tracking data. Logistics managers need a sophisticated tool to integrate the electronics real-time tracking data with the advanced United Terminal IMS to analyze the bottleneck of operation flows, the processing time of different cargo-handling equipment and the average waiting time of the inbound and outbound ships.

4.2 *United Terminal IMS*

The Nagoya United Terminal IMS is a computer-aided information management system used for planning for vessels, cargo-handling equipment and yard storage planning. Figure 3 shows the flow for the container operations and the data flows via the Nagoya United Terminal IMS. When a ship berths at the container terminal, a container is discharged by a quay crane and is unloaded onto an inside tractor that is waiting to transfer material to the yard storage blocks. Once the container is unloaded onto the bed of the tractor, the information on the loading completion will be transferred to the IMS. Nearly at the same time, handling instruction for containers-storage spots will be sent to cargo-handling equipment at the yard, including transfer cranes, straddle careers, and top lifters. It is possible to send these information to the next job in advance of the actual tractor arrival. In addition, it is valuable for the cargo-handling equipment at the yard to choose the next job in helping to make the proper decisions. In the meantime, the Nagoya United Terminal IMS will record the exact time when instructions are sent out as well as the time that handling completion information is accepted.

4.3 Data Collection and Processing

The overall flow of the data processing in this study is shown in Fig. 4. The electronic real-time information regarding the operation processes is designed for performing simulations repeatedly and effectively. Selected resultant input data for a real container terminal simulation is summarized in Table 1. A similar idea for creating experimental data for simulation experiments appears in the simulation of hospital wards (Takakuwa and Katagiri 2007; Wijewickrama and Takakuwa 2006). The simulation can be performed automatically, using a model together with the input data. Therefore, a judicious integration of real-time data into the simulation model will reduce the work load of specification, coding, validation, and verification of the simulation.

4.4 Simulation Logic

Computer simulation is a methodology that can be used to describe, analyze and predict the performance of a complex business process without the limiting assumptions. In this paper, the simulation model is conducted with the Simio modeling software, version 3.48 (Kelton et al. 2010; Pegden and Sturrock 2010).

The fundamental operation processes in a typical terminal including importing and exporting processes are shown in Figs. 5 and 6. The importing process means that an inbound container is discharged from an inbound vessel by a quay crane and is unloaded onto an inside tractor that transfers material to the yard storage blocks.

The exporting process is that an outbound container is loaded onto a tractor by cargo-handling equipment at the yard, such as transfer cranes, straddle careers, and top lifters, then transferred to an outbound vessel by quay crane. By using Simio modeling software, dynamic 3D animated models of container terminals can be built efficiently.

4.5 Analysis

The simulation model can be run to examine the overall operation processes for all of the cargo for the coming day, based on the exact electronic real-time data

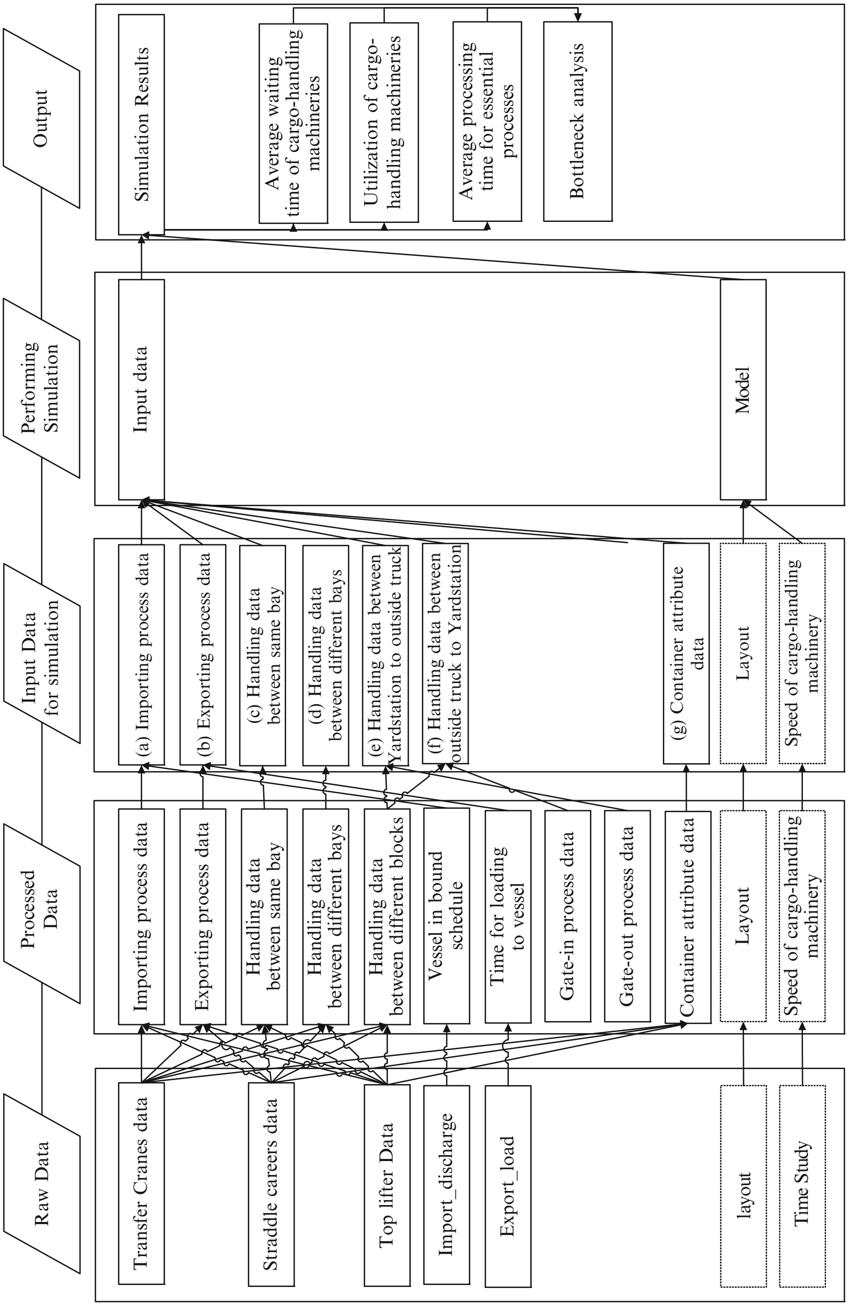


Fig. 4 Overall flow of data processing

Table 1 Selected resultant input data for the simulation of an actual container terminal

(a) Importing process						(Operation types: UL and TU)
No. (Priority No.)	Container No.	Vessel No.	Berth crane No.	Real time of loading completion for a truck	Truck No.	Real time of handling instruction for a cargo-handling machinery
1	TRIU8380996	STNG	1	9.18	KR024	9.06
2	NSSU0072627	HTYO	4	10.71	TX170	10.69
Real Time of last job finished for a cargo-handling machinery	Cargo-handling machinery No.	Block No.	Bay No.	Row No.	Real time of job finished for a cargo-handling machinery	
9.18	TC11	1F	15	4	9.29	
10.62	TC11	2F	12	3	10.80	
(b) Exporting process						(Operation types: LD)
No. (Priority No.)	Container No.	Cargo-handling machinery No.	Block No.	Bay No.	Row No.	Real time of handling instruction for a cargo-handling machinery
1	PCSU2120915	TC18	2C	40	5	10.98
2	PCSU2108036	TC18	2C	40	6	11.01

(continued)

Table 1 (continued)

Real Time of last job finished for a cargo-handling machinery	Real time of job finished for a cargo-handling machinery	Truck No.	Berth crane No.	Vessel No.		
11.01	11.03	KP118	V4	HTYO		
11.03	11.06	TK136	V4	HTYO		
(c) Handling between the same bay in a block						(Operation types: RS and IS)
No. (Priority No.)	Container No.	Cargo-handling machinery No.	Block No.	Bay No.	Row No. (from)	Row No. (to)
1	CRSU6022868	TC11	1F	17	2	3
2	YMLU7415614	TC11	1F	10	2	3
Real time of handling instruction for a cargo-handling machinery	Real Time of last job finished for a cargo-handling machinery	Real time of job finished for a cargo-handling machinery				
8.80	8.80	8.87				
9.36	9.34	9.43				
(d) Handling between different bays in a block						(Operation types: IB)
No. (Priority No.)	Container No.	Cargo-handling machinery No.	Block No.	Bay No. (from)	Row No. (from)	Bay No. (to)
1	CKLU4107919	TC30	3E	07	04	04
2	PCLU4050914	TC30	3E	07	05	04

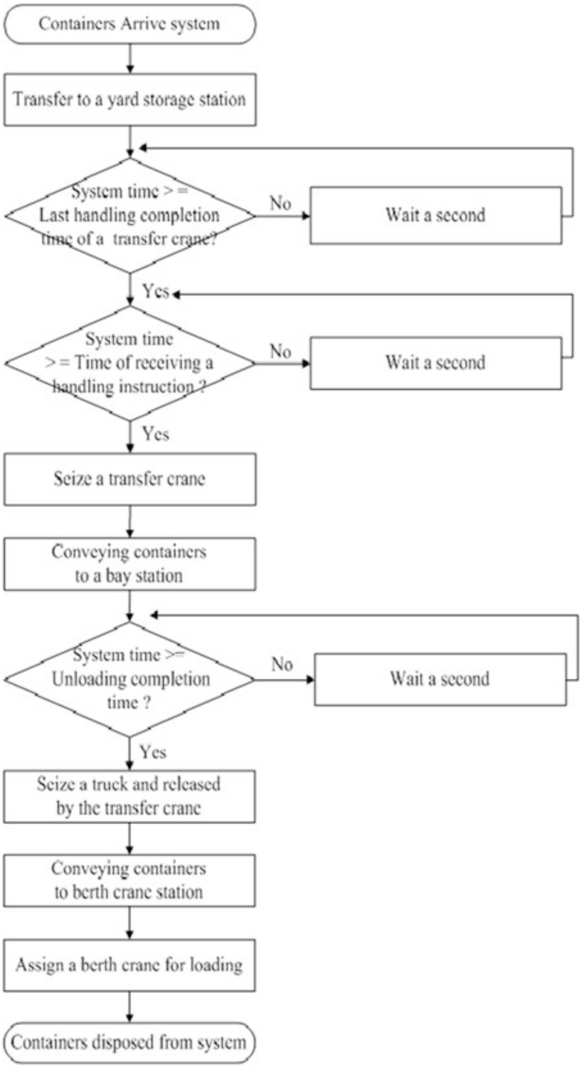
Row No. (to)	Real time of handling instruction for a cargo-handling machinery	Real Time of last job finished for a cargo-handling machinery	Real time of job finished for a cargo-handling machinery			
05	7.57	8.32	8.36			
04	7.57	8.36	8.40			
(e) Handling between yard station to outside tractor						(Operation types: SO and D)
No. (Priority No.)	Container No.	Cargo-handling machinery No.	Block No.	Bay No.	Row No.	Real time of handling instruction for a cargo-handling machinery
1	KKTU7880852	TC15	1J15051	15	05	8.41
2	DFSU2085042	TC15	1J15022	15	02	8.41
Real Time of last job finished for a cargo-handling machinery	Real time of job finished for a cargo-handling machinery					
8.63	8.67					
8.67	8.69					

(continued)

Table 1 (continued)

(f) Handling between outside tractor to yard station						(Operation types: SI and R)
No. (Priority No.)	Container No.	Cargo-handling machinery No.	Block No.	Bay No.	Row No.	Real time of handling instruction for a cargo-handling machinery
1	SNBU2114676	TC11	2F	33	02	8.50
2	TRIU8666969	TC26	2E	27	01	8.51
Real Time of last job finished for a cargo-handling machinery	Real time of job finished for a cargo-handling machinery					
8.52	8.57					
8.55	8.58					
(g) Container attributes						
Container No.	Size	Type	Height	FE (Full = 1/Empty = 0)	Weight	Vessel name
PCSU2120915	20	DC	86	1	15,563	HTYO
CRXU6921757	40	RC	86	1	28,900	JID

Fig. 5 Exporting process for a typical terminal



of the day. By performing the simulation, a number of performance measurement variables can be recorded and output. A part of the simulation results about tracking the outgoing containers is shown in Fig. 7. The average or maximum total time in this system can be analyzed and outputted by performing simulation. This result can be used to improve the performance of materials handling at the container terminals.

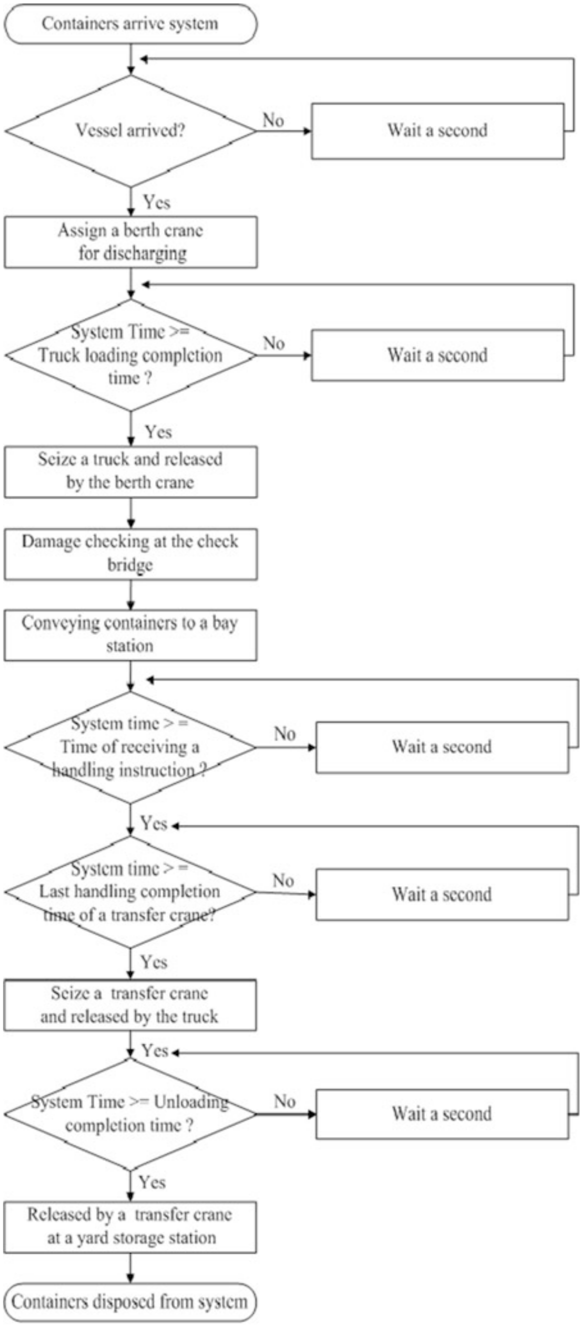


Fig. 6 Importing process for a typical terminal

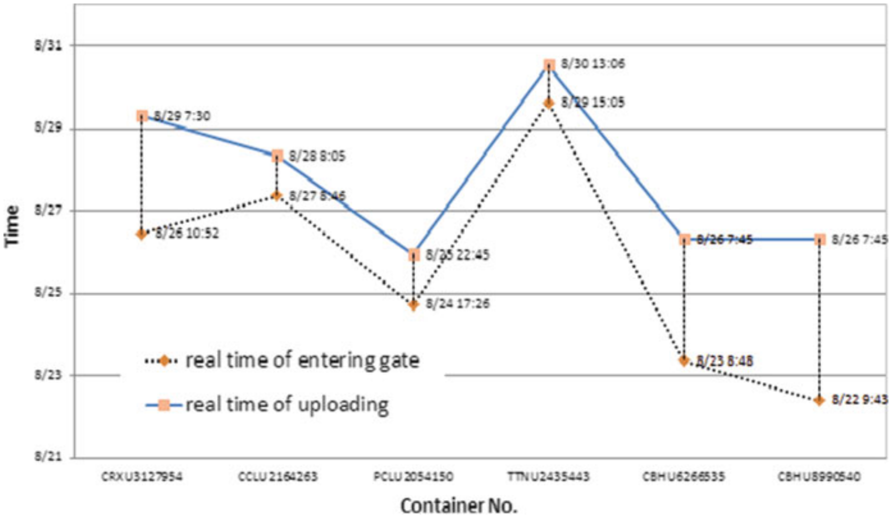


Fig. 7 A part of the simulation result about total time of containers in system

5 Conclusions

In this paper, by making use of electronic real-time tracking data that is accumulated from united terminal IMSs, a procedure is proposed to aid materials handling management for container terminals.

The proposed procedure is applied to an actual container terminal in Japan in order to confirm its effectiveness. It is found that the information obtained by performing simulation is effective for analyzing the performance of the materials handling operations at container terminals. In addition, the procedure is generic and can easily be expanded to model other ports.

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A Traffic Simulation System Based on Platform-Plugins Structure

Xu-hai Chen

Abstract This paper firstly analyzes the customizability traffic simulation systems in terms of three tiers, then proposes a traffic simulation system based on platform-plugins structure. The simulation system itself is composed by a simulation kernel and function module interface specifications, all specific function module can be customized by the users according to their demands. Then key approaches and some implementation details are introduced. Finally its effects are also shown through an application case. This paper raises a highly available approach for general-purpose traffic simulation system.

Keywords Traffic simulation system • Customizability • Platform-plugins structure • Hardware-in-loop simulation

1 Introduction

Road traffic system is a complex system with complex structure, multi-factors, strong openness, randomness and much instability. It is difficult to use the method of field experiments to analyze such a system. Therefore, system simulation technology has become an effective tool to study transport system (Ma Shoufeng and He Guoguang 1998; Shang Lei and Lu Hua-pu 2006). Because different users of simulation system aim to solve different problems and any kind of traffic simulation systems cannot be expected to meet all the specific needs of the end users at designing and developing period, versatile simulation system must have the ability through which the end user can customize their own requirement. The simulation system "can be customized (customizability)" can be divided into three levels as follow.

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1. Totally not customizable. Users can only do the simulation in total accordance with the original system design logic. Except for some simulation programs in specific purpose, almost all the existing simulation systems will not be designed to be totally not customizable.
2. Customized via parameters. Users can modify the system configuration files to adjust the system parameters, such as changing the arrival rate of the vehicle, changing the vehicle's maximum speed, modifying signal timing, modifying road geometry parameter and so on. It is currently the most common customization form and can meet the needs of most users.
3. Higher level customization must allow users to customize the behavior of key modules and allow the users to change the operating logic of some modules of the original system. As in the traffic simulation system, the users can write a new traffic flow model or traffic control strategy according to their need and add them to the system to do the simulation.

Obviously, the third level of customization is the ideal solution because the most direct method is to modify the code. However, in general the users of simulation system do not have the source code of the system and do not have the ability to modify the code. Therefore, dynamic customization and extend functionality are required to upgrade the general simulation system. Academia to solve this problem also proposed some preliminary ideas (He Zhen huan et al. 2003). Some academic researchers have also proposed some preliminary ideas to solve this problem.

In this paper we present an open structure traffic simulation system based on platform-plugins structure and introduce the structure and principle of this kind of simulation system. Then we show the practical application effect of the system in the background of project application.

2 Principle of the Traffic Simulation System Based on Platform-Plugins Structure

Traffic simulation system generally includes traffic module, network module, control module, user interface and so on. The implementation of these modules is not within the scope of this paper. In this paper we focus on the structure and principle of the simulation system. Different to most of the existing simulation systems, we use the designing method of platform-plugins structure (Li June and Zhou Dongru 2007; Zhou Bing and Li Xuzhi 2010; Bao Liang and Chen Ping 2006) in this paper. The simulation system itself only includes a simulation kernel and interface specification of the key module in the traffic simulation system, system critical functions the concrete realization of a separate written conforming interface specification. Implementation of the key functions in the system is connected to the simulation kernel in the form of separate written, conforming interface specification

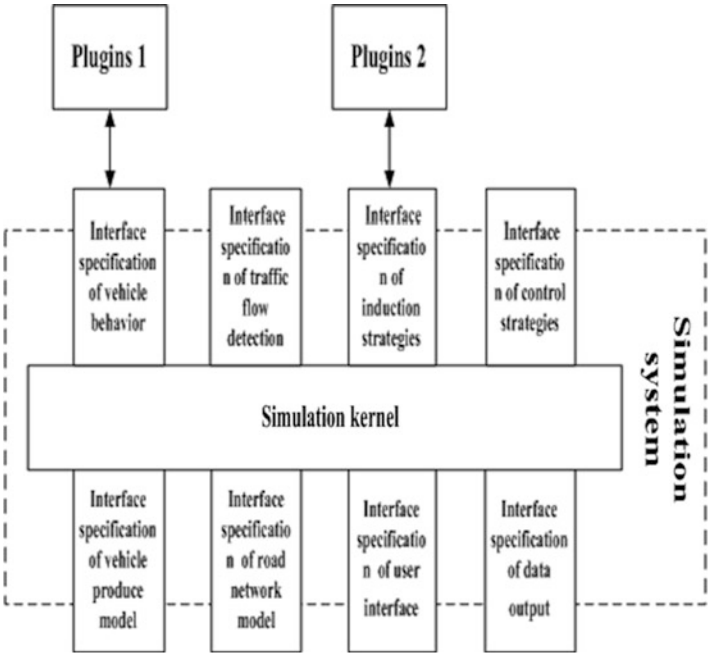

Fig. 1 The structure of simulation system platform

and function-independent plugins. The three components are linked with each other via the simulation kernel and thus complete the implementation of the traffic flow simulation. The system structure can be expressed in the form of Fig. 1.

In this simulation system, the simulation kernel is the core of the system. However, it does not involve with specific functions of traffic flow simulation. The main role of the simulation kernel is to call and coordinate the various specific functional modules in order to complete the simulation task. In addition, the simulation kernel has to ensure the stability of the program, management and registration of the plugins. It provides outward extension interface at the same time. When writing the plugins, users can get access to the kernel and other modules resources and data through the extension interface of the simulation kernel to complete the plugins' function itself.

Traffic flow simulation requires specific function modules, such as vehicle behavior module, control induction strategy module and so on. The modules have only an agreed interface specification in the simulation system, but no specific functions. Specific function are embodied in the form of plugins and they are written by the user according to the interface specification and by calling the extension interfaces of the simulation kernel. At last, the modules are dynamically added to the system.

3 Implementation of Traffic Simulation System Based on Platform-Plugins Architecture

There are two key points in the implementation of the simulation system, firstly, providing users with flexible and easy to use plug-in writing methods. Secondly, plug-ins can be easily loaded into the platform. Traditional ways of simulation system implementation includes a script-interpreter, dynamic link libraries, or COM components, but some of those are inflexible or complicated, It’s difficult for user to write plug-ins. because the implementation of simulation system in this article uses the .Net development platform, which provides a number of mechanisms so that it can combine the advantages of the implementation ways mentioned above.

3.1 Implementation of Plug-ins

The implementation of plug-in comes from mainly the “interface-oriented programming” thought, the interface specification is designed as a virtual base class, the core functions of the module is defined in the base class in the form of virtual function. When users write a plug-in, simply inherit the base class and override virtual function in accordance with the requirements, this ensures that the user feels free to write plug-ins, but emulation in the kernel doesn’t have to know the specific implementations of these add-on features, just following the standard schedule is good enough, the stability of the system is ensured, meanwhile users are allowed with the most flexibility. Take the most important part of traffic simulation system – traffic control module as an example, its structure is shown in Fig. 2.

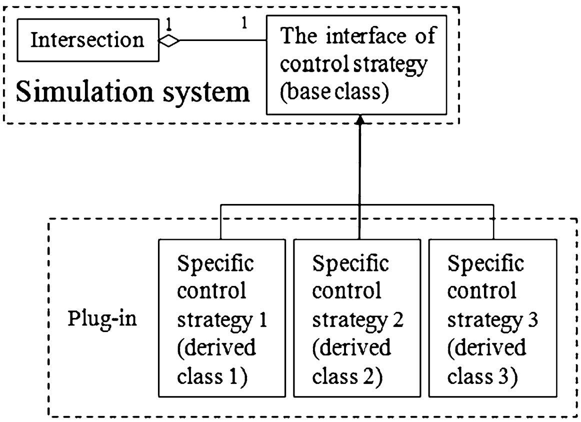

Fig. 2 Interface specification and implementation of plug-ins

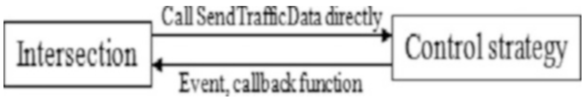

Fig. 3 Relationship between intersection class and control strategy class

First of all is the primary interface of simulation kernel, logically speaking, each specific control strategy is subject to an intersection, therefore in simulation kernel, every intersection class contains a reference to the base class of control strategy, key members on signal control in intersection categories include:

1. void SendTrafficData(TrafficData data); Passing the real-time traffic flow data of simulation system to the control strategy class.
2. void AddController(BasicSignalCter ctr); Specifies a control strategy for the intersection, parameter is assigned by the users to specify a specific policy (instance of the control strategy class) reference.
3. traffic matrix A and the list of links L traffic matrix is used to indicating the relationship between intersection and various sections of the road, if, the traffic is allowed between and, otherwise it is not allowed.

Key members of the base class of control strategy including:

1. phase list, where "phase" is one of the traffic control terminology, representing the situation whether Vehicle is allowed to pass between junctions within an intersection. In the simulation system, for an N-ary intersection, a phase is represented as a two-dimensional Boolean matrix of N*N. If k-phase control happens at an intersection, the list contains k two-dimensional matrix.
2. traffic flow data buffer tdataBuffer, store the received traffic flow data in it.
3. void ChangePhase(int i); Convert traffic light color to the I-th phase.
4. void virtual ControllerRun(); Users need to implement this virtual function in a custom control strategy, control algorithms are written under specific control rules. The ChangePhase function is called when the phase changing condition is satisfied.

Due to intersection needs to provide traffic flow data to control policy, and phase conversion also effect the passage situation of intersection, to avoid intersection class and control strategy class from getting tightly two-way coupled, signal control strategy effect intersection in the form of "event": control strategy class registered a event in intersection class, when function ChangePhase is called, this event is triggered, and matrix will be the parameter passed to intersection class in the callback function, so the traffic matrix is changed, the purpose of changing the state of traffic flow is achieved (Fig. 3).

Other module plug-ins are similar to the implementation of control strategies, due to space limitations, I am not going to repeat them. In addition, because the .Net provide the common language runtime (CLR) environment, all programs developed

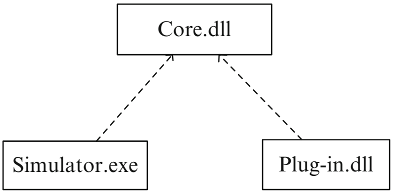

Fig. 4 The physical structure of the simulation system

in languages which are compliant with the common language specification (CLS) are allowed to run with the simulation system, so that users can use any language .Net platform supports to write a plug-in, thus the scope of the system is expanded.

3.2 *The Dynamic Loading of Plug-in*

The dynamic loading of plug-in is achieved by using the Reflection provided by the .Net (Perry 2005). In the .Net, after the source code is compiled, it does not generate a binary machine code, but rather generate assemblies described by the intermediate language (IL) of the .Net, actually, .exe and .dll files generated from the .Net compiler are all assemblies, rather than conventional Window PE files. Assemblies are a kind of self-describing metadata, by the Reflection, we can access to external assemblies at run time, check its version, classes it contains and properties and methods contained in a class, it provides a way to building objects through the class name and get the information of the class.

The main program of the simulation system is broken down into two assemblies, the first assembly is Simulator.exe, which provides the basic framework of main program. The second assembly is Core.dll, it contains a simulation kernel and interface specifications of each functional module. When you write a plug-in, first of all, you should establish a new assembly and reference the Core.dll, because all the interface specifications are defined in Core.dll, users only need to inherit specific virtual base classes according to their own needs, use the extended interfaces provided by the simulation kernel for specific functions, and to compile the plug-in to .dll file, and the writing of a plug-in is just completed. It is found that in this system, the forms of user-written plug-ins are .dll files, but what to note is, these .dll files are different from conventional dynamic link library files, actually they are the .Net assemblies (Fig. 4).

The dynamic loading of plug-in is achieved by specifying the plug-in file name in the “Simulation scenarios” file, where the “Simulation scenarios” file is an XML file which defines the geometry of road network, the simulation time, the data to be collected and the specific name of the plug-ins. Here is a fragment of “simulation scenarios” file:

```
 <Cross>
     <Object_ID>0</Object_ID>
     <x>439</x>
     <y>312</y>
     ......
   <SignalType>Controller.ActuatedSignal
</SignalType>
</Cross>
```

Node <Cross> </Cross> represents the definition of a intersection in the scene, which mainly describes the shape of the intersection and its location information, of which <SignalType>Controller.ActuatedSignal</SignalType> represents the control algorithm used for the intersection is the virtual signal base class "ActuatedSignal" which is defined in the plug-in "Controller.dll". After getting the location and the name of the plug-in from a scene file, the simulation kernel use the reflection to build the object dynamically through the class name, and began to start the simulation.

4 The Application Case

This section introduced the typical application of traffic simulation system with a specific engineering application case.

The majority of traffic control methods should be tested in traffic simulation system before being put into practical use (Luo Xianglong et al. 2010). Since the principle and procedure of the control algorithm could be completely different, the need will not be satisfied if the signal control module of the simulation system only provides the modification of time plan. Therefore, for general simulation system, you must allow the user to write the program of control algorithm, and added it to the simulation system to do experiments. It can be seen that traffic control module is one of the modules that demand openness most in the traffic simulation system (Zhao Xiaohua et al. 2006). In the development process of YBK-3 signal controller, due to the extraordinary high cost of frequent on-site experiments, hardware-in-loop simulation is used. Hardware-in-loop simulation is a technology to connect the controller (entity) and the simulation model that control objects in computer to do test (Zhang Hengyuan and Li Zhi 2005). In this application, the simulation model that control objects is the traffic flow in traffic network in the simulation. The entity of controller is signal control equipment. Hardware-in-loop simulation is to utilize the actual signal devices to control the simulation of traffic flow, work in software and hardware is both required to be done (Fig. 5):

Hardware part: A signal machine interface board is needed as the physical device to connect the signal machine and PC machine. It is comprised of 8,051 single

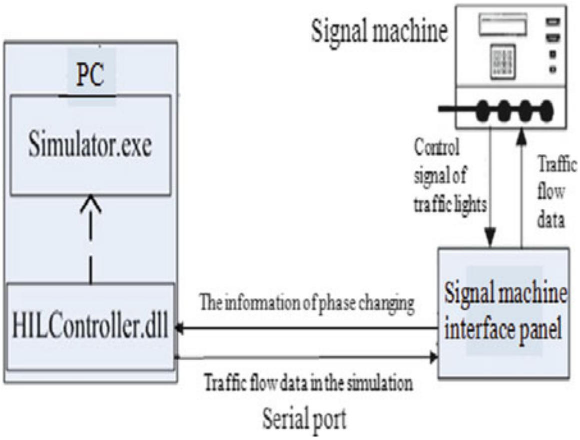

Fig. 5 Hardware-in-loop simulation structure

tablets machine and the perimeter circuit, it has connection with PC machine by serial interface, and is connected to signal machine through serial interface (Detector data interface) and cable (color lamp control) respectively. It transmit the traffic flow information to signal machine and transmit the output of signal machine – the control signal of signal lights is conversed into specific format and transmitted to PC machine by serial made for the use of simulation system. Through signal interface board, Hardware-in-loop simulation can be conducted without any changes in hardware or software of signal machine.

Software part, a signal control algorithm plug-in is needed to be the software media that links the simulation system and actual signal machine, key implementation steps are as follows:

1. Set up the simulation test scene based on experimental purposes.
2. Reference the Core.dll and create a derived class of the signal control modules interface "BasicSignalCter" named by HILController, any development languages that the platform supports can be used due to the features of .Net platform.
3. Define phase list, in hardware-in-loop simulation, the phase number of signal control class HILController should be identical with the actual signal controller, and the corresponding phase should be exactly the same, for instance, for most common two-phase control, two phases are: go straight and turn left in east-west direction, go straight and turn left in north-south direction (no restrictions on turning right).
4. Rewrite the virtual function ControllerRun() defined in a BasicSignalCter, implement the procedure of control algorithm in this virtual function, for application in this instance, the procedure of the control algorithm is: First, check the traffic flow data buffer, and transmit the latest data directly to the actual signal machine. Then read the serial interface data, when it receives a phase changing information sent by the interface board, call the function ChangePhase to change the traffic

conditions of intersections in the simulation; if it no signal is received, current phase should be maintained.

5. To compile the custom control algorithms into a. dll file.
6. Modify the configuration file of simulation scenario, HILController is designated to be the control algorithm in the configuration file, simulation kernel generates the objects of control algorithm dynamically while loading the simulation scenario file, and connected them with the specified intersection object and start simulation.

The control algorithm plug-in of hardware-in-loop simulation is completed through the above steps. It can be seen that, in this case, the plug-in does not include the complete process of signal control, but only for data format conversion and transmitting, however, because it is completely in line with the control module interface specification, therefore, it can be loaded and ran properly. This case shows the flexibility and the generality of platform-plugin structure simulation system.

5 Conclusion

This paper introduces a traffic simulation system based on platform-plugins architecture, and by applying the "platform-plugins" software architecture, system users are allowed to customize different module function of the system under the situation of not changing simulation system code. With the help of Common Language Runtime provided by .Net platform, users can adopt C#.Net, VB.Net or Managed C++ to write function plugs. The function plugs can be added to the system dynamically only by altering configuration files, which reduces the difficulty of users' writing and using plugins. Finally, the concrete realization and application of system are exhibited via signal control module. This paper provides a new method for developing universal traffic simulation system.

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Part II
Engineering Management – Accounting and Finance

The Volatility and Cycle of Emerging Industry Stock Market in China: An Empirical Study Based on EEMD

Ying-qing Gong

Abstract Great demand and growth potentiality of emerging industry provide a good investment opportunity for capital market. This paper proposes to analyze the volatility and cycle characteristics of the China's emerging industry stock price by using EEMD. The IMFs decomposed by the EEMD could reveal the volatility and cycle characteristic of China's emerging industry stock market, and furtherly reconstruct IMFs by signal test could see the short-term volatility caused by the game of the buyer and the seller, the medium-term volatility caused by events and the long-term volatility decided by the residue of emerging industry stock market. This study reveals the volatility trend and its cycle characteristic of emerging industry stock prices, which not only complement the existing research on investment in emerging industries, and also provide a reference for guiding investment practice.

Keywords EEMD • Emerging industry stock price • Volatility

1 Introduction

Globalization and communication technology deeply change the world economy structure, and thus give birth the time of a new economy, the most optimal economic form nowadays (Pohjola 2002). Emerging industry which represents a new level of industrialization of science and technology and a new direction of the transformation of the industrial structure is resulted by the promotion of scientific and technological revolution, and it is already become the common choice of the country around world

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after the financial crisis. China emphasized the strategic significance of emerging industries as well. The great market capacity and growth expectation of emerging industry provides a good opportunity for investment in new industries. The better return of emerging industries' stock market means it has its own rule of volatility and market cycle.

Researches in financial area have studied the volatility of the capital price, and many models of measuring or estimating this kind of volatility have built as well. To conclude, those models could be divided into two categories: static and dynamic. Static model is generally assumed that the variance of the price or yield is stable, but financial markets research found that majority of the financial variables variance is not stable, on the contrary, the phenomenon of heteroscedastic and volatility clustering are more often to be seen. Therefore, dynamic models such as Moving Average, Generalized Autoregressive Conditional Heteroskedasticity (Bollerslev 1986) are developed. Nevertheless, both static and dynamic model were built on the basis of difference. Chaotic finance believes that the system based on the demand by differential logarithmic yield model could introduce white noise which destructs the properties of chaotic as a result (Ping Chen 1996). Theory of Real Business Cycle think that the Hodrick-Prescott (HP) filter (Hodrick and Prescott 1981, 1997) could be used to analyze the rule of sequence variation, according this theory, time series can be divided into volatile component and a trend component (Lucas 1977). The chaotic theory further pointed out that the fluctuating component contains a sequence of chaotic characteristic feature, and the fluctuation's characteristic of non-cyclical fluctuations is called "intrinsic period". Nevertheless, HP algorithm has an inherent defect, its parameters are generally selected by the subjective, and HP filter will produce a false frequency in the presence of the unit root (Cogley and Nasonb 1995). Thus, some scholars use Empirical Mode Decomposition (EMD) to study the trend digestion and volatility problems in economy basing on the transform of Hilbert Huang (Hilbert-Huang Transform, HHT) (Huang 1998). The EMD's is useful not only in the intuitive trend extraction sequence, and also provide local variation in economic time series as a prominent local frequency change filter. The EMD method has a high signal-to-noise ratio which is suitable for analyzing non-linear and non-stationary signal sequence, but its limitation of easy to produce mode hybrid is very obvious as well. However, EEMD method can effectively resolve this limitation.

Therefore, this paper uses EEMD to study the stock volatility law of emerging industry. China's stock market has two emerging index: SSE Emerging industries index (SSE merging) and CSI Emerging Industries index (CSI Emerging). EEMD quantitative analysis finds that the two index decomposition results are similar, which means one is enough for analyzing. Considering contrast with the Shanghai Composite Index (SCI), we select SSE merging as the sample of this analysis. Therefore, this paper select SSE Merging and SCI's closing price from 2005 to 2012, 1,883 samples all together, to do EEMD filtering, data are come from Wind Database.

2 EEMD Decomposition Method

Ensemble Empirical Mode Decomposition (EEMD) is a noise assisted data analysis method based on empirical mode decomposition (Empirical Mode Decomposition, EMD), the time-frequency analysis method proposed by Huang (1998). The basic idea is to obtain the intrinsic mode functions (IMF) by decomposing the nonlinear and non-stationary signals basing on the local variation of the signal, which makes the IMF become narrowband signal. As a result let $x(t)$ be the emerging industries Indices, the EMD is:

$$x(t) = \sum_{i=1}^{n} x_i(t) \tag{1}$$

Give the signal $x(t)$, the decomposition steps of EMD are as follows,

1. Identify all extreme points of the original emerging industry stock index time series $x(t)$ to determine the local maximum value set $x_{\max}$ and local minimum value set $x_{\min}$.
2. Cubic spline function to interpolate between the extreme points, fitting out the sequence on the upper envelope $e_{\max}(t)$ and lower envelope $e_{\min}(t)$.
3. Calculate the average line $m_1(t) = (e_{\max}(t) + e_{\min}(t))/2$, the difference of original new industry stock index and local extreme $h_1(t) = x(t) - m_1(t)$.
4. Substitute $x(t)$ with $h_1(t)$, and repeat the steps above, until the average envelope tends to 0 after k times cycle, then $h_{1k}(t)$ is the first IMF as a result, and $F_1(t) = h_{1k}(t)$. Separate $F_1(t)$ from the original emerging industries stock index $x(t)$, $r_1(t) = x(t) - F_1(t)$, and let $x(t) = r_1(t)$;
5. Repeat the steps above, until $r_n(t)$ or $F_n(t)$ is smaller than the predetermined threshold value or the residual component $r_n(t)$ become a monotonic function, then the EMD decomposition of $x(t)$ come to end. The result of the decomposition is,

$$\begin{aligned} x(t) &= F_1(t) + r_1(t) = F_1(t) + F_2(t) + r_2(t) = \cdots \\ &= \sum_{i=1}^{n} F_r(t) + r_n(t) \end{aligned} \tag{2}$$

EMD method have high signal-to-noise ratio and it is suitable for the analysis of non-linear, non-stationary signal series. But EMD is easy to produce mixed mode, which reducing the physical significance of the IMF functions. So, Wu and Huang (2009) proposed the EEMD method, which using white noise to guide the sub-signal of EMD for solve the problem of mode mixing (Wu and Huang 2009). The steps of EEMD including,

1. Synthesize all white noise of finite amplitude with the analyzing data: $x(t) = x(t) + w_i(t)$.

2. To decompose synthetic data according to the EMD algorithm
3. Repeat the above steps, add a different white noise sequence, we get another IMF, and calculate the average of all IMF got from repeated process of above process, it is the real IMF.

EEMD decomposition is efficient for decomposing the non-linear, non-stationary time series signals, and it is helpful for examine the potential data structures. In this paper, we use the EEMD method.

3 EEMD Decomposition of the Emerging Industry Stock Price

3.1 Descriptive Statistics

From Table 1, the Jarque-Bera test and ADF test of SSE emerging and the SCI suggesting that the two indices are non-normal distribution and non-stationary. Therefore, it is more appropriate to use non-liner model to describe the stock price volatility.

3.2 EEMD Decomposition

Following parameters set in other research (Zhang et al. 2008), we set the EEMD 100 times new signal synthesis-decomposition, each time adding a standard deviation, 20 % standard deviation of corresponding index as the white noise. The EEMD decomposition results of SSE emerging stock index shown in Fig. 1.

In Fig. 1, SSE emerging stock index solid mode function amplitude and frequency changing over time. The residue r was asperity type extends upward curve, on behalf of the SSE emerging long-term certainty trend upwards. As to

Table 1 Statistic and test result

Index	SSE emerging	SCI
Sample	1,883	1,883
Min.	669.27	1,011.5
Max.	7,073.33	6,092.26
S.d.	1,761.26	1,046.94
Jarque-Bera	136.249***	297.343***
ADF(c,T)	−1.188	−1.153
ADF(c,0)	−1.665	−1.451

***denote statistical significance at the 1 % level respectively

c and *T* denote intercept term and trend term respectively in the ADF test

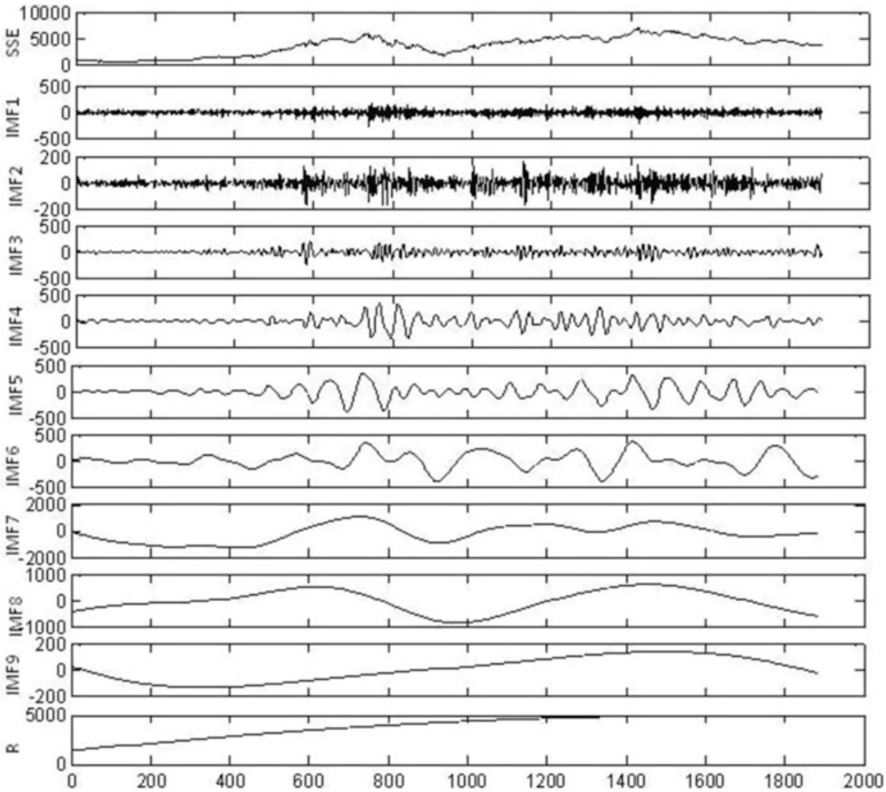

Fig. 1 EEMD decomposition of SSE emerging

the nine intrinsic mode functions, the highest frequency and amplitude changes is IMF1, its average period is 3.3 days, and on the 740th day, it reaches more than 250. IMF2 has a period of approximately 8 days. IMF3's average period is 17 days, the amplitude come to its peak on the 583th day, IMF4's average period is 33 days, the maximum amplitude reached 360 on the 766th day, IMF5's period is 50 days, reaches its maximum amplitude up to 380 or more between the 697th day to the 699th day. IMF6's average period is 100 days, it reach the higher value of more than 350 from the 745th day to the 749th day, also reached a high value of 370 or more between the 1340th day to the 1345th day. IMF7 average period is 600 days, the amplitude is fluctuate from 0 to 1,000. IMF8 average period is 1,000 days, amplitude fluctuate between 500 and 1,000. IMF9 is close to sinusoidal fluctuations. Residue is an approximate upward protrusions curve, gradually increase from the 1,328 days on the first to 2,825 days on the 1635th day, despite downward trend after a while, but substantially is more than 4,700.

As to SCI, IMF1 to IMF6's average cycle is longer than SSE emerging except the IMF3, the amplitude range is wider than SSE emerging, and the characteristics of IMF7 to IMF9 is similar to emerging SSE (Fig. 2).

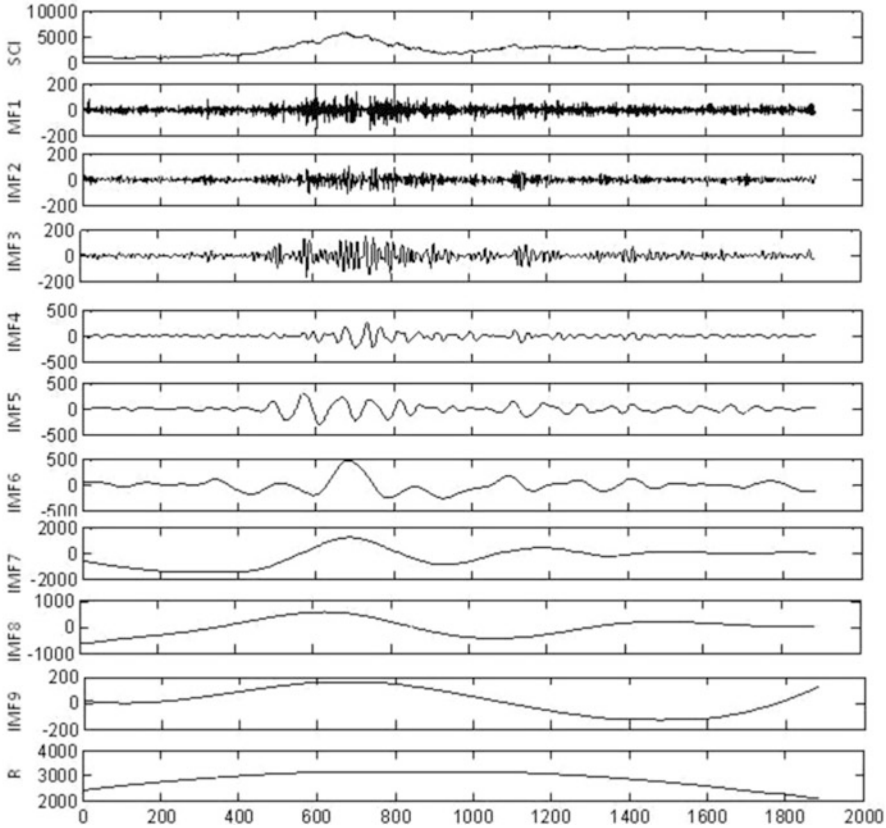

Fig. 2 EEMD decomposition of SCI

Table 2 is each IMF's contribution to the original price index. Differ from the SSE emerging, SCI's IMF7, IMF8 are the most relevant component, which contribute up to 80 % of its variance changes. The relevance and explanatory residue of SCI are not only inferior to IMF7 and IMF8, but also is declining as time, mainly due to the time range of the sample selected, during which the stock was shocked great by the financial crisis in 2008. The decline trend of the sample could explain more that the SSE emerging stock market outperformed the stock market as a whole.

3.3 Analysis of the Decomposition Results

To better analyze the different fluctuations of inherent mode's impact on the fluctuations of stock index, and understand the changes in the structural characteristics of the stock index fluctuations as well, we make a signal test and reconstruct the

Table 2 Correlation and variance ratio

	SSE emerging			SCI		
	Pearson	Kendall	Ratio[a] (%)	Pearson	Kendall	Ratio (%)
IMF1	0.019	0.018	0.12	0.029	0.026*	0.12
IMF2	0.037	0.038*	0.09	0.043*	0.036**	0.07
IMF3	0.053**	0.045***	0.15	0.060***	0.030*	0.17
IMF4	0.086***	0.066***	0.48	0.061***	0.058***	0.37
IMF5	0.138***	0.010***	0.90	0.150***	0.077***	0.99
IMF6	0.219***	0.134***	1.34	0.365***	0.108***	2.24
IMF7	0.835***	0.599***	23.69	0.878***	0.657***	70.15
IMF8	0.451***	0.405***	9.87	0.678***	0.449***	12.76
IMF9	0.768***	0.592***	0.48	0.271***	0.102***	1.18
Res.	0.864***	0.621***	62.87	0.451***	0.367***	11.95

[a]The ratio of variance to the total
*, **, *** denote statistical significance at the 10 %, 5 % and 1 % level

Table 3 Correlation and variance ratio of the reconstructed IMF

		High-frequency part	Low-frequency part	Residue
SSE emerging	Pearson	0.225***	0.853***	0.864***
	Kendall	0.155***	0.655***	0.621***
	Ratio	3.92 %	42.42 %	53.66 %
SCI	Pearson	0.149***	0.953***	0.451***
	Kendall	0.086***	0.738***	0.367***
	Ratio	1.77 %	89.35 %	8.88 %

*** denote statistical significance at the 1 % level respectively

IMFs. The signal reconstruction inspection is to accumulate IMF gradually from high to low and at the same time test whether it is significantly differ from 0 (Zhang et al. 2008). Reconstruction the IMF and the t-test results show that, for the SSE emerging, the sum of IMF1 toIMF6 represents the short-term fluctuations, and the remaining is medium-term; for SCI, the sum of IMF1 to IMF5 is short-term fluctuations in composition, and the rest of the ingredients are for the mid-term fluctuations. The results of relevance and ratio of variance of the reconstructed IMF is as shown in Table 3.

Know from Table 3, the residual has the highest correlation to SSE emerging, 53.66 %'s variance change of SSE emerging come from the residue, and the low-frequency part explain up to 42.42 % as well, which is far higher than the high-frequency part.

Residuals, the low-frequency part and high frequency part imply a strong economic meaning, which can be used to reveal the intrinsic characteristic implicit in the SSE emerging sequence. The residual item can be used to describe the SSE emerging's long-term trend. The turning point of the low-frequency curve up and down is related to the significant event in the emerging industry's stock market, such as the financial crisis, the macro-control policy, industrial policy etc. Disordered

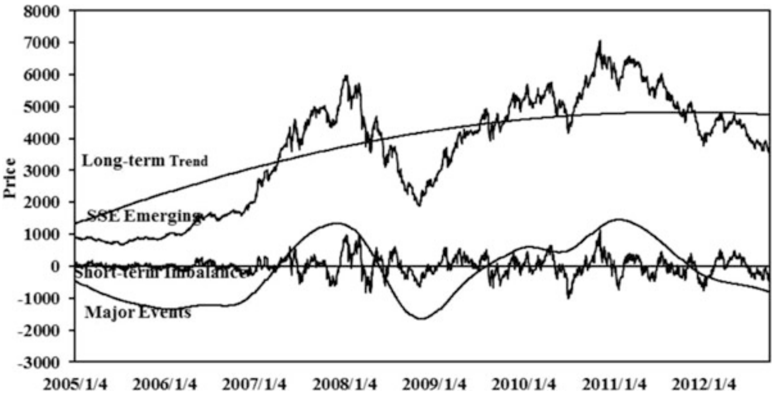

Fig. 3 Long-term trends, events, and short-term fluctuations

high-frequency curve random fluctuations around zero mean line can be used to reveal the short-term imbalances in the stock markets of emerging industries, its amplitude could be used to judge the imbalance degree of the of the market.

3.3.1 Long-Term Trend

Residuals can be used to represent the long-term trend of the stock markets of emerging industries. Residue is highly correlated to the actual trend of SSE emerging, its Pearson correlation coefficient is as high as 0.8638, Kendall coefficient is 0.6211, and the residuals can explain 53.66 % variance changes of SSE. Therefore, residual basically decide the actual trend of the stock market of emerging industry. Figure 3 shows that the residuals is 1,328 at the beginning, and reached maximum value of 4,825 in mid-September 2011 to October, despite residual term downward trend during the subsequent period of time, but still has been maintained at the high level of more than 4,744. From the market development in 2005 to now, the compound annual growth rate of SSE the emerging is 17.25 %, which means that the stock market of the emerging industry tends to a steady growth for a long time, and, irregular random short-term market fluctuations, major events taking place in emerging industries will not affect the long-term trend of it.

Compared the market trend and macroeconomic trends at the same period, we can also see that the stock market performance of emerging industries market is far more better than the stock as a whole, and is also better than the macroeconomic fundamentals.

3.3.2 Major Events

The low-frequency curve represents a major event in the stock markets of emerging industries in the medium-term fluctuations. From Fig. 3 shows that, since 2005, the

SSE has two main larger cycles. From the end of 2005 to 2008, there was a large cyclical fluctuations, this cycle is similar to the trend of the SCI Index over the same period.

Except macroeconomic, industrial policy of Emerging industries also play an important role on affecting the stock market trend. By the end of November 2008, SSE gradually recovered from the financial crisis over, and starts to increasing, just correspond with the three emerging strategic industry forums held by ex-Prime Minister Wen Jiabao in 2009. Although experience a slight decline after a while in 2010, it soon began to rise and continued its upward trend due to the impact of the State Council in October 2010 which passed an important decision on the promotion of the development of new industries.

Began on January 2011, the low frequency part of SSE emerging stock index began to decline, and change from positive to negative on November 2011. This shows that the volatility risk of emerging stock index, the callback needs of the pre-over-rising, and the impact of the macroeconomic environment overall decline after the 2008 financial crisis as well. On May 30, 2012, Ex-prime minister Wen Jiabao presided over the executive meeting discussed and adopted the "Twelfth Five-Year national strategic emerging industry development plan" which put forward the development direction, major tasks and 20 projects of the seven strategic emerging industries. On July 15, 2012, the "Twelfth Five-Year national strategic emerging industry development plan" issued and proposed to promote the rapid development of related industries, the GNP proportion rose from 8 % in 2015 to 15 % in 2020. Although low frequency part of SSE emerging stock index is still in decline since May 2012, and its decline is greater than the stock as a whole, but this is mainly due to the impact of the decline in the macroeconomic environment. With the carrying out of the "12th Five-Year Plan", and the bottoming out of macroeconomic in the foreseeable future, emerging industry stock index will rise out of a new cycle.

3.3.3 Short-Term Market Imbalance

High-frequency curve of emerging industries stock market is used to represent the degree of short-term imbalance caused by the game of buyer and seller. In general, imbalanced of the market is very often to see, small oscillation is normal. But when frequency curve amplitude huge fluctuates for several weeks, it is likely there are speculative investment behaviors. Seen from Fig. 3, the high-frequency part of the emerging stock index SSE can probably be divided into two parts: before 2007, SSE emerging stock index fluctuation is relatively stable, lower frequency, amplitude between −200 to 200. After 2007, volatility of SSE emerging stock index began to intensify, the amplitude range to between −1,000 to 1,000. The change of fluctuation's frequency and amplitude around 2007 certainly has to do with the split share structure reform, but in general, the SSE emerging stock index has a larger degree of speculative factors than SCI. Compared the SCI at the same period, we also know, even for SCI's highest amplitude over the same period, it fluctuates less than 600, this is much lower than the 1,000 for SSE.

In addition to speculative factors, the greater short-term fluctuations of SSE emerging stock index also reflect industry characteristic of emerging industries itself. Emerging industry is in the infancy and growth stage of the industry life cycle, there is great uncertainty on this stage, coupled with its start-up stage, and no rules of the game, it filled with opportunities and risks as a result (Porter 1980). From the throughout industry value chain, China's emerging industrial development is not entirely mature, its transformation to autonomous industry value chain is very difficult transition. The absence of autonomous industrial value chain means that China's listed companies in emerging industries is not high quality. At the same time, due to the huge difference of various types of enterprises in the emerging industrial, even in the sub-sectors, there are significant differences about products, technologies, and markets. Traditional invest analysis method, and the valuation method of all different opportunities are not applicable for emerging industries. In addition, the capital market environment including the market system, the structure of investors etc. are not perfect, which further increase the risk of investment in new industries.

4 Conclusion

In this paper, we use EEMD to empirical analyze SSE Emerging Industries Index. Results show SSE emerging index have trading period of 8-days cycle, the 17-day trading cycle, 33-day cycle, 50-day cycle, 100-day cycle, 600-day cycle and 1,000-day cycle, these morphological characteristics implied that the emerging stock market will be subject to some kind of shocks, and can form a clear memory.

The Signal Reconstruction results show that, IMFs could be further reconstructed into three parts: the Short-term volatility caused by the game of buyer and seller of the market, the Medium-term volatility caused by events and the long-term volatility decided by the residue. Residuals basically deicide the long-term trend of emerging industry stock market, a nearly upward convex curve of the residue means the emerging industry stock market tends to grow steadily in the long-term. About the events, except macroeconomic environment, relevant industrial policies are important factors that affect the trend of the emerging industry stock market, especially, the discussion and pass of the Decision of the State Council on Accelerating the Fostering and Development of Strategic Emerging Industries by the State Council on October 18 2010, directly promoted a booming of a new rising cycle of emerging stock index. The high-frequency curve represents the short-term affect by the game of the buyer and the seller. From the trend of the high-frequency curve, the volatility amplitude and frequency of SSE emerging is huge, and larger than the SCI, that means there is much more speculative characteristics in SSE emerging.

Overall, the emerging industry is the main content of the future economic development. Investment in emerging industries will have great returns in the long time, especially since 2008, its investment performance is better than the stock market as a whole. With the "12th Five-Year Plan" is carrying out, and the end of the macroeconomic in the foreseeable future, the bull market of emerging industry is worth anticipate. However, we should also know that compare to the stock market as a whole, the volatility of emerging industry stock index is larger, and it has more speculative factors. Combing its own risk as a new industry and the probability of market impact from the internal or external economic environment, we have to say, that investing in emerging industries have high risk as well.

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The Downturn of Stock Market and the Irrational Exuberance of Leveraged Funds: A Case Study on Yinhuaxinli in SZSE

Yong-jun Qi, Kai-guo Yin, and Hai-yan Zhong

Abstract Although the issuing of stock funds became increasingly difficult during the downturn in China's stock market from 2011 to 2012, classification funds with leveraged character developed rapidly with the number of new funds growing and the shares of old funds increasing during this time. High leveraged funds such as Yinhuaxinli even developed into irrational exuberance. "Irrationality" was reflected in their trading prices having substantial premiums relative to their net values. "Exuberance" was not only reflected in their shares growing rapidly, but also reflected in their trading volumes and turnovers reaching one new record to another even when the whole market declined significantly. However, Yinhuaxinli's special liquidation brought huge irreparable losses to its investors after its irrational exuberance. There are many reasons behind their irrational exuberance, and anchoring effect, sunk cost effect and gambler's fallacy effect are the important ones. The lessons from such case study include not using leverage excessively and establishing a clear stop-loss point for leverage products.

Keywords Irrational exuberance • Leveraged fund • Premium

1 Introduction

Classification funds developed rapidly with the number of new funds growing and the shares of old funds increasing since Changsheng Fund Management Co., Ltd. launched Changsheng Tongqing (fund code: 160806), the first classification fund in China. The leveraged shares of the classification funds (as referred to "leveraged funds" below) even developed into irrational exuberance in 2012 (Shiller 2006). These just occurred during the time of the downturn in China's stock market with

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the issuing of other stock funds becoming increasingly difficult and the large-scale redemptions becoming more common. In the following, we will take Yinhuaxinli as an example to illustrate the irrational exuberance of leveraged funds, and to analyze the reasons behind their exuberance from the behavioral finance perspectives (Dan 2010). After that, we will give some advice to investors in the above situation.

2 The Characteristics of Yinhuaxinli

The basic shares of a classification fund can generally be split into some fixed-income shares (often referred to as "fixed-income funds") and some leveraged shares (often referred to as "leveraged funds") according to a predetermined ratio. Taking Yinhua China Securities Average Weighted 90 Index Classification Fund (the basic fund, also called Yinhua 90 for short, trading code: 161816) as an example, two shares of Yinhua 90 can be split into one share of Yinhuajinli (the fixed-income fund, trading code: 150030) and one share of Yinhuaxinli (the leveraged fund, trading code: 150031). Yinhuaxinli, the leveraged fund has the following characteristics:

2.1 The Financing Cost Is High

The change of the net value in the underlying asset is fully borne by Yinhuaxinli because the fixed-income fund Yinhuajinli has a fixed annual income of 1-year time's deposit rate of PBC plus 3.5 %. This is equivalent to each share of Yinhuaxinli not only using its own fund to buy the stocks of China Securities Average Weighted 90 Index, but also borrowing RMB 1 yuan from Yinhuajinli to buy the same stocks, and then paying the interest for the borrowed money on the first trading day of the next fiscal year. This rate is 7 % in 2012. In addition, Yinhuaxinli has to pay 1 % of the net value of both Yinhuaxinli and Yinhuajinli to the fund managers as management fee and 0.22 % of that to the trustee as custodian fee. If we add other fees such as bank charges, the cost of fund information disclosure, the fund shareholders' meeting costs, the accountants' fees, legal fees, etc., Yinhuaxinli's financing cost is about 8.5 % in 2012. Only if the prices of the stocks in which Yinhuaxinli invested rise sharply, can Yinhuaxinli's investors make some profit from owning them. Otherwise, if the prices only rise gently, the profit may just be enough to pay the financing cost; if the prices fall, Yinhuaxinli's investors will not only bear all the losses, but also have to pay the high financing cost.

2.2 Its Leverage Ratio Has Great Variation

Because the shares of Yinhuaxinli and Yinhuajinli are always 1:1, the leverage ratio of Yinhuaxinli is constantly changing with both of their net values. The leverage ratio is 2 when these funds were first established, which means Yinhuaxinli's net value changes 2 % with 1 % change in the net worth of the underlying assets. If the net worth of the underlying assets rises by 50 %, Yinhuaxinli's net value will be close to RMB 2 yuan and Yinhuajinli's net value will be a little more than RMB 1 yuan if the interest accrued to it, and Yinhuaxinli's leverage ratio will drop to 1.5-fold. If the net worth of the underlying assets decreases by 25 %, Yinhuaxinli's net value will be close to RMB 0.5 yuan and Yinhuajinli's net value will also be a little more than RMB 1 yuan, and Yinhuaxinli's leverage ratio will rise to three-fold. This means the higher its net value, the lower its leverage ratio, and vise versa.

2.3 Special Liquidation Terms Restore the Leverage and Partially Liquidate Their Net Values

Yinhua 90 and Yinhuajinli regularly liquidate at the end of first trading day in each fiscal year, and this is equivalent to Yinhuaxinli paying the yearly interest owed to Yinhuajinli. In addition, they will go into special liquidation processes when Yinhua 90s net worth is more than RMB 2 yuan or Yinhuaxinli's net worth is less than RMB 0.25 yuan. When the former happens, their net values restores to RMB 1 yuan, and the parts above RMB 1 yuan convert into the basic fund, Yinhua 90. This is equivalent to liquidating the parts of their net values above RMB 1 yuan and restoring the leverage ratio of Yinhuaxinli to two-fold. When the latter happens, the part of Yinhuajinli's net value above Yinhuaxinli's converts into the basic fund, and their net values restores to RMB 1 yuan with the proportional reduction of their shares according to Yinhuaxinli's net value. This is just like liquidating the part of Yinhuajinli's net value above Yinhuaxinli's and restoring Yinhuaxinli's leverage ratio to two-fold.

3 The Irrational Exuberance of Yinhuaxinli

The trading of the leveraged funds was not affected during the downturn of China's stock market from 2011 to 2012, and it even developed into the overall irrational exuberance. Taking Yinhuaxinli's trading as an example, the irrational exuberance was mainly manifested in the following aspects:

3.1 Trading at a High Premium

Yinhuaxinli's monthly net values, closing prices and premium rates from its listing in April 2011 to its first special liquidation in August 2012 are shown in Table 1. As we can see from the table, its monthly closing prices were much higher than its net

Table 1 Yinhuaxinli's net values, closing prices and premium rates at the end of each month

Time	Net values (RMB yuan)	Closing prices (RMB yuan)	Premium rates (%)
Apr. 2011	0.940	1.003	6.70
May 2011	0.833	0.924	10.92
Jun. 2011	0.864	0.952	10.19
Jul. 2011	0.814	0.896	10.07
Aug. 2011	0.719	0.842	17.11
Sep. 2011	0.557	0.815	46.32
Oct. 2011	0.600	0.737	22.83
Nov. 2011	0.476	0.601	26.26
Dec. 2011	0.373	0.477	27.88
Jan. 2012	0.458	0.612	33.62
Feb. 2012	0.541	0.673	24.40
Mar. 2012	0.423	0.553	30.73
Apr. 2012	0.520	0.650	25.00
May 2012	0.518	0.658	27.03
Jun. 2012	0.408	0.562	37.75
Jul. 2012	0.326	0.464	42.33
Aug. 2012	0.243	0.280	15.23

values during this period. Especially at the end of September 2011, its net worth was RMB 0.557 yuan a share, but its price closed at RMB 0.815 yuan with a premium of RMB 0.258 yuan or 46.32 %. Later, Yinhuaxinli's premium rate fell somewhat, but remained at the level of more than 20 % since then.

At the end of July 2012, Yinhuaxinli's net worth fell to RMB 0.326 yuan and its leverage ratio rose to more than four-fold. If the price of the whole market had continually fallen only slightly, Yinhuaxinli's net value should have broken the threshold of RMB 0.25 yuan and entered into a special liquidation process. But investors completely ignored the possibility and still bought the fund at a high premium of more than 40 % in great quantity even though SZSE issued the risk warning of the special liquidation again and again.

In the evening of August 30, 2012, SZSE clearly issued the announcement that the next day was the special liquidation date, and the trading of Yinhuaxinli would be suspended 1 h from 9:30 a.m. to 10:30 a.m. after the stock market opening. These two acts put together did take effect on that day with Yinhuaxinli's closing price falling 6.35 %, but investors still did not come to full rationality because the closing price of RMB 0.28 yuan was 15.23 % higher than its net value of RMB 0.243 yuan of that day. Yinhuaxinli's leverage ratio and premium rate reduced significantly after the special liquidation, and this brought huge irreversible losses to investors who bought Yinhuaxinli in great quantity before its special liquidation.

Figure 1 shows the changes of Yinhuaxinli's net values and its closing prices more vividly from its listing in April 8, 2011 to its first special liquidation in August 31, 2012 total to 345 trading days. The gaps between them are the premiums of its closing prices relative to its net values.

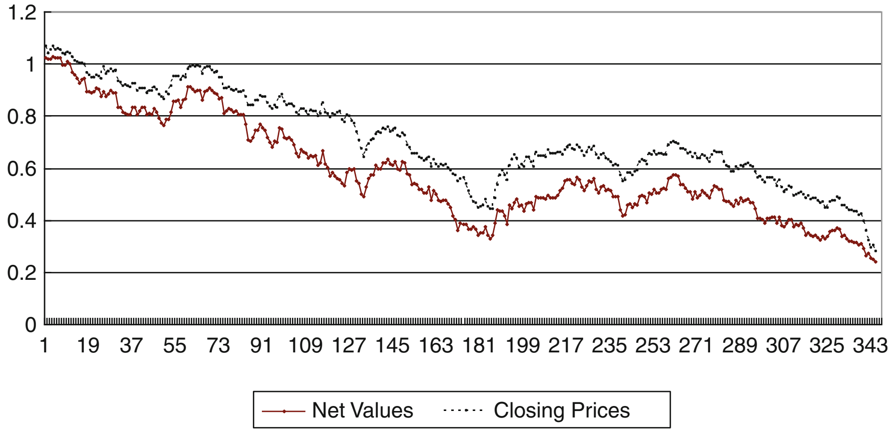

Fig. 1 Yinhuaxinli's net values and closing prices on trading days

As we can see from the analysis of Yinhuaxinli's net values, closing prices and premiums in Table 1 and Fig. 1, the investors speculated heavily on Yinhuaxinli and its trading prices seriously went against the efficient market hypothesis. If Yinhuaxinli's investors were optimistic about the overall trend of China's A-shares, they could buy CSI300 index futures with corresponding period. If its investors were only optimistic about some of its underlying stocks, they could directly buy these stocks, mortgage them to get extra funds and use these newly obtained funds to buy them again. The investors could become leveraged on the above methods, but did not have to pay such high premiums for the underlying stocks. In addition, although China's A-shares fell sharply during this period, the average prices of the A-shares were still more than 10 % higher than that of H-shares for the companies listed both in Chinese mainland and Hong Kong. Most importantly, SZSE issued the special liquidation warns again and again during this period. Once it happens, it is like a liquidation according its net values. Therefore, there was no justification to pay such high premiums at that time whether from the point of view of investment value or from the point of view of investment risk.

3.2 Shares Growing Rapidly

In contrast to the continued decline in its net values, Yinhuaxinli's shares grew substantially during this period. Figure 2 shows its shares since its listing in April 8, 2011 to its first special liquidation in August 31, 2012. As we can see from the figure, there were 777.82 million shares on the first day of its listing. They grew slowly during the whole 2011, but suddenly grew rapidly in 2012. Its shares had reached 1.97 billion at the end of the first quarter of 2012 with an increase of 112.22 % compared to that at the end of 2011, and then its shares rocketed to 4.91 billion at

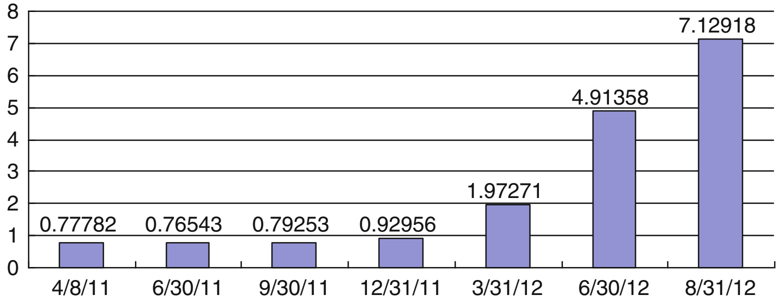

Fig. 2 Yinhuaxinli's shares on some days (billion)

Table 2 Yinhuaxinli's monthly trading volumes and turnovers

Time	Trading volumes (hand)	Turnovers (RMB yuan)
Apr. 2011	6,809,596	709,566,095
May 2011	3,056,002	290,292,846
Jun. 2011	3,221,620	294,012,007
Jul. 2011	4,735,047	455,099,683
Aug. 2011	4,462,278	382,631,972
Sep. 2011	6,750,251	548,387,370
Oct. 2011	5,640,119	409,091,585
Nov. 2011	6,640,939	466,662,127
Dec. 2011	8,325,229	433,336,718
Jan. 2012	22,828,581	1,345,121,351
Feb. 2012	64,390,175	4,175,052,928
Mar. 2012	32,453,729	2,073,188,820
Apr. 2012	38,559,418	2,415,452,848
May 2012	64,375,171	4,224,761,320
Jun. 2012	74,377,654	4,416,670,112
Jul. 2012	132,314,044	6,728,022,608
Aug. 2012	214,602,218	8,567,171,024

the end of second quarter of 2012 and 7.13 billion on the day of its first special liquidation. It developed into unprecedented prosperity after its listing, especially in 2012. This suggested that the high premium on its trading price was the result of the irrational exuberance formed by many enthusiastic investors, rather than the result of the speculations made by few people.

3.3 *Trading Volumes and Turnovers Surging*

Yinhuaxinli's irrational exuberance was not only reflected in the high-speed growth of its shares, but also reflected in its trading volumes and turnovers which are shown in Table 2. As we can see from the table, Yinhuaxinli's trading volumes were less than ten million hands and its turnovers were less than RMB one billion yuan each month in the whole 2011. With the high-speed growth of its shares, Yinhuaxinli's trading volumes and turnovers also grew rapidly in 2012. In January, its trading volume exceeded 20 million hands with a turnover of more than RMB 1.34 billion yuan. February was the most active month for China's stock market and Yinhuaxinli's trading was no exception. Its trading volume reached to 64.39 million hands with a turnover of RMB 4.18 billion yuan in that month. Though the trading volumes and turnovers declined sharply in the next 2 months, they were still extremely active with the trading volumes of more than 30 million hands and the turnovers of more than RMB two billion yuan monthly. In July 2012, its trading volume surpassed 100 million hands with a turnover of RMB 6.73 billion yuan. Especially in August, SZSE issued six times of the risk warning of the special liquidation when Yinhuaxinli's net value was approaching to RMB 0.25 yuan, the threshold of the special liquidation. But these announcements did not arouse investors' attention, and they continued playing the game of "greater fool" which would come to an end immediately. The trading volumes surpassed 200 million hands with a turnover of RMB 8.567 billion yuan in that month, and more than 70 % of the volumes were trading at the price of more than 30 % of their net values.

4 The Reasons for the Irrational Exuberance of Yinhuaxinli

Yinhuaxinli's irrational exuberance could hardly happen without the broad participation of many investors. Their irrational behavior was mainly caused by the following factors:

4.1 Anchoring Effect

The net value of RMB 1 yuan at Yinhuaxinli's setting up became the "anchor" of many investors. When the whole market fell, its net value would decline more rapidly because of its high leverage, and its investors would lower its trading price accordingly, but at a speed much lower than its net value because of the anchoring effect (Brown and Cliff 2005). When the downturn of China's stock market continued very long, the premium was not only accumulated, but also enlarged considerably.

4.2 Sunk Cost Effect

Although Yinhuaxinli's trading price declined sharply along with the downturn of the stock market, it was still not adjusted to the level of its net value (Trueman 1988).

Because of the sunk cost effect, many investors were unwilling to sell Yinhuaxinli at the current market price, although its net value had already been seriously diminished. Some investors even put more funds to increase their holdings, looking forward to a large rebound of the market. This resulted in a substantial premium on the one hand and the rapid growth of its shares on the other hand.

4.3 Gambler's Fallacy Effect

China's A-shares declined continually since Yinhuaxinli's listing, and its net values fell more rapidly because of its high leverage. Affected by the "gambler's fallacy", some investors bought more shares to take advantage of its high leverage, hoping that the market would rebound soon and thus recoup their previous losses (Trainor 2010). Unfortunately, the large rebound which the investors expected did not come. Yinhuaxinli's investors was trapped into the "gambler's fallacy" deeper and deeper with more money put into this fund. After the special liquidation, they had to accept the harsh reality – Yinhuaxinli's high premium and high leverage only brought huge irreparable losses for them.

5 The Lessons from the Irrational Exuberance

Yinhuaxinli's special liquidation caused irreparable losses for many investors, and there are some profound lessons we can learn from it:

5.1 Do Not Use Leverage Excessively

Yinhuaxinli is a financial product with its initial leverage ratio setting at two-fold. As its net values shrank continually, its leverage ratio rose to 3.82-fold at the end of 2011, and was close to five-fold just before its first special liquidation. Its investors seemed to only dream the tempting profits, and completely ignored the risk of special liquidation, trading at the prices of more than 20 % of its net values on most trading days (Zimmerman 2010). After its special liquidation, 1 share of old Yinhuaxinli converted to 0.243 share of new one with the new net value at RMB 1 yuan, and its leverage ratio restored to two-fold. It meant that its investors could regain their initial investment only if the whole stock market would rise at least 150 %.

5.2 Establish a Stop-Loss Point

If Yinhuaxinli's investors has set a clear stop-loss point, they would sold the fund early before its trading prices completely returned to rationality. In addition, if the investors set a clear stop-loss point, they would be relatively easy to get rid of sunk costs attachment (Ferguson and Leistikow 2004). This would not only help them to avoid further losses in their early investment, but also help them to avoid greater losses resulted from subsequent additional investment.

6 Conclusion

Through the above study on Yinhuaxinli, the highly leveraged fund, we can see that although the issuing of stock funds became increasingly difficult and the large-scale redemption became more common during the downturn in China's stock market from 2011 to 2012, classification funds with leveraged character developed rapidly with the number of new funds growing and the shares of old funds increasing during this time. High leveraged funds such as Yinhuaxinli even developed into irrational exuberance. "Irrationality" was reflected in their trading prices having substantial premiums relative to their net values (Ross 2002). "Exuberance" was not only reflected in their shares growing rapidly, but also reflected in their trading volumes and turnovers reaching one new record to another even the whole market declined significantly (Palomino 1996). However, Yinhuaxinli's special liquidation brought huge irreparable losses to its investors after its irrational exuberance. There are many reasons behind their irrational exuberance, and anchoring effect, sunk cost effect and gambler's fallacy effect are the important ones (Trueman 1988). The lessons from such case study include not using leverage excessively and establishing a clear stop-loss point for leverage products.

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Securities Analysts' Competence: Model Design and Application

Jia-ni Wang

Abstract This paper constructs securities analysts' competence model with 20 indicators. It uses survey and Delphi methods. The fuzzy comprehensive evaluation is used to evaluate the competence of securities analysts in China. The results show that securities analysts are not competent in every category. The results show that securities analysts are incompetent as a whole. Especially they perform worse in "forecast accuracy", "forecast objectivity", and "innovation and independence". This paper concludes that the comprehensive qualities of domestic securities analysts should be further enhanced.

Keywords Competence • Evaluation • Fuzzy comprehensive • Securities analyst

1 Introduction

Securities analysts' ability has been controversy for scholars. A large number of researchers discussed securities analysts' forecast accuracy (Brown and Rozeff 1978; Dowen 1989; Calderon 1993; Chopra 1998), information content in investment rating (Elton et al. 1986; Stickel 1995) and market reaction (Logue and Tuttle 1973; Brown et al. 1987; Baginski and Hassell 1990) based on rating data and earnings forecast in analysts' report database. They focused on the performance of securities analysts' competence, which is a kind of afterward evaluation. The systematic evaluation on securities analyst competencies is not enough. However, those findings and are inconsistent, due to different measure method, samples and variables (Ramnath et al. 2008).

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This paper will create a model of analyzing securities analysts' professional competence comprehensively and effectively and what actors do it contains? To solve these problems, this paper originally using the competence model created by American psychologist David McClelland (1973), and investigates the securities analysts' competence in China. This can provide evidence for the securities analysts' evaluation, training and public policy making in China. This paper uses questionnaire, Delphi and other research methods.

2 Elements of Securities Analysts' Competence

According to David McClelland (1973) and Spencer (1993), securities analysts' competence is defined by securities analysts' potential capability to obtain excellent results in their job. This can help managers distinguish the excellent and the mediocre.

Regulation in Association of Certified International Investment Analysts points that analysts' professional competence and ethics are two important factors of securities analysts' competence. In the United States, code of ethics and standards of professional conduct is the basic rule for Chartered Financial Analyst Institute in Association for Investment Management and Research. According to the rules and content of CFA exam (Caccese 1997), securities analysts' competence should include three aspects: knowledge (including economics, finance, investment, accounting, financial management, case studies, law, statistics, English, etc.), code of ethics (including honesty, fairness and impartiality, independence and objectivity, independence and objectivity) and professional skills (including logical thinking ability, technical proficiency, learning ability, research ability, interpersonal skills, and prudent judgment, investment decision-making ability) (CFA Institute 2007).

Through the job description of securities analyst in three popular recruitment website in China including China HR, Zhaopin and 51 job, it is found that the qualities of securities analysts include high education, for example, acquiring a master degree and qualification certificates in securities industry, work experience, strongly independent analytic capability, logical analysis, planning, word processing capabilities, as well as communication and coordination skills, fast learning and innovation and so on. These requirements could be seen as indicators for analyzing securities analysts' competence.

3 Securities Analysts' Competence Model

3.1 Indicator System and Indicator Assemblage

According to the indicator system of securities analysts' competency, we get the indicator assemblage:

$$\mathrm{U} = \{u_1, u_2, u_3, u_4\} \tag{1}$$

Table 1 The Indicator System

Target	First-level	Second-level
Securities analysts' competency (U)	Knowledge and work experience (u_1)	Education (u_{11}), work experience (u_{12}), foreign language (u_{13}), qualifications/certificates (u_{14}), specialization (u_{15})
	Working capability (u_2)	Learning capability (u_{21}), information search and processing (u_{22}), logical thinking (u_{25}), stress tolerance (u_{24}), communication and coordination skills (u_{25})
	Job performance (u_3)	Forecast accuracy (u_{31}), forecast objectivity (u_{32}), value delivering (u_{33}), market identity (u_{34})
	Moral and characteristics (u_4)	Ethics (u_{51}), self-control (u_{52}), being insightful to market (u_{53}), innovation and independence (u_{54}), being conscientious and hard working (u_{55}), emotion management (u_{56})

In (1),

$$
\begin{aligned}
\mathrm{u}_1 &= \{u_{11}, u_{12}, u_{13}, u_{14}, u_{15}\}, \\
\mathrm{u}_2 &= \{u_{21}, u_{22}, u_{23}, u_{24}, u_{25}\}, \\
\mathrm{u}_3 &= \{u_{31}, u_{32}, u_{33}, u_{34}\} \text{ And} \\
\mathrm{u}_4 &= \{u_{41}, u_{42}, u_{43}, u_{44}, u_{45}, u_{46}\}
\end{aligned}
$$

$u_1, \ldots, u_4$ Stand for four first-level indicators and $u_{11}, \ldots, u_{46}$ stand for twenty second-level indicators in the system.

The indicator system of securities analysts' competency is structured through depth interview. We consulted 20 experts, including managers in Securities Research Department and HR Department, the senior analysts and professional investors, etc., and designed the indicator system. The system includes four first-level indictors and twenty second-level indicators which can comprehensively estimate securities analysts' competency. See Table 1.

Cronbach's α coefficient passes the test of reliability (>0.7), which means that there is good internal consistency among these indicators.

3.2 Evaluation Assemblage

Comprehensive evaluation on securities analysts' competency is used to identify securities analysts' qualities and performance. We get the evaluation assemblage:

$$
\mathrm{V} = \{v_1, v_2, v_3, v_4, v_5\} \tag{2}
$$

In (2), v_1, v_2, v_3, v_4, v_5 stand for 'worse', 'bad', 'average', 'good' and 'excellent' respectively. According to the concept of competence, the securities analyst is competent if the result from comprehensive evaluation is 'excellent'.

3.3 Weighting Value for Indicators

Weighting value is gained through Delphi method. The weighting value assemblage for first-level indicators is as follows:

$$A = \{a_1, a_2, a_3, a_4\} \tag{3}$$

In (3), $a_1 + a_2 + a_3 + a_4 = 1$.

The weighting value assemblage for second-level indicators is as follows:

$$\mathrm{a}_1 = \{a_{11}, a_{12}, a_{13}, a_{14}, a_{15}\} \tag{4}$$

$$\mathrm{a}_2 = \{a_{21}, a_{22}, a_{23}, a_{24}, a_{25}\} \tag{5}$$

$$\mathrm{a}_3 = \{a_{31}, a_{32}, a_{33}, a_{34}\} \tag{6}$$

$$\mathrm{a}_4 = \{a_{41}, a_{42}, a_{43}, a_{44}, a_{45}, a_{46}\} \tag{7}$$

In (4), $a_{11} + a_{12} + a_{13} + a_{14} + \mathrm{a}_{15} = 1$,
In (5), $a_{21} + a_{22} + a_{23} + a_{24} + \mathrm{a}_{25} = 1$,
In (6), $a_{31} + a_{32} + a_{33} + a_{34} = 1$,
and in (5), $a_{41} + a_{42} + a_{43} + a_{44} + a_{45} + a_{46} = 1$.

3.4 Weighting Value for Indicators

The fuzzy evaluation matrix is constructed by use of evaluation on all levels of indicators.

We get the first-level evaluation matrix:

$$\mathrm{R} = \begin{bmatrix} \mathrm{R}_1 \\ \mathrm{R}_2 \\ \vdots \\ \mathrm{R}_4 \end{bmatrix} = \begin{bmatrix} \mathrm{R}_{11} & \dots & R_{15} \\ R_{21} & \dots & R_{25} \\ \vdots & \ddots & \vdots \\ R_{41} & \dots & R_{45} \end{bmatrix} \tag{8}$$

In (8), $\mathrm{R}_{11}, \ldots, \mathrm{R}_{45}$ stand for evaluation on first-level indictors each of which has five evaluation values.

We get the second-level evaluation matrix:

$$\mathrm{R}_1 = \begin{bmatrix} \mathrm{r}_{11} \\ \mathrm{r}_{12} \\ \vdots \\ \mathrm{r}_{15} \end{bmatrix} = \begin{bmatrix} \mathrm{r}_{111} & \cdots & r_{115} \\ r_{121} & \cdots & r_{125} \\ \vdots & \ddots & \vdots \\ r_{151} & \cdots & r_{155} \end{bmatrix} \tag{9}$$

$$\mathrm{R}_2 = \begin{bmatrix} \mathrm{r}_{21} \\ \mathrm{r}_{22} \\ \vdots \\ \mathrm{r}_{25} \end{bmatrix} = \begin{bmatrix} \mathrm{r}_{211} & \cdots & r_{215} \\ r_{221} & \cdots & r_{225} \\ \vdots & \ddots & \vdots \\ r_{251} & \cdots & r_{255} \end{bmatrix} \tag{10}$$

$$\mathrm{R}_3 = \begin{bmatrix} \mathrm{r}_{31} \\ \mathrm{r}_{32} \\ \vdots \\ \mathrm{r}_{34} \end{bmatrix} = \begin{bmatrix} \mathrm{r}_{311} & \cdots & r_{315} \\ r_{321} & \cdots & r_{325} \\ \vdots & \ddots & \vdots \\ r_{341} & \cdots & r_{345} \end{bmatrix} \tag{11}$$

$$\mathrm{R}_4 = \begin{bmatrix} \mathrm{r}_{11} \\ \mathrm{r}_{12} \\ \vdots \\ \mathrm{r}_{46} \end{bmatrix} = \begin{bmatrix} \mathrm{r}_{111} & \cdots & r_{115} \\ r_{121} & \cdots & r_{125} \\ \vdots & \ddots & \vdots \\ r_{461} & \cdots & r_{465} \end{bmatrix} \tag{12}$$

In these equations, $r_{111}, \ldots, r_{465}$ stand for evaluation of all second-level indictors.

3.5 Fuzzy Comprehensive Evaluation

The indicator system of securities analysts' competency is multilevel, so we use multi-level fuzzy comprehensive evaluation; that is to say, firstly doing first-level comprehensive evaluation on each sub aggregate, then doing second-level comprehensive evaluation (Hu and Hong 2004).

We get the first-level evaluation vector:

$$B_i = A_i * R_i = (b_{i1}, \cdots b_{i5}) \tag{13}$$

and the second-level evaluation vector:

$$B = A * R = (b_1, \cdots b_5) \tag{14}$$

The result of Fuzzy Comprehensive Evaluation is acquired by the Maximum Fuzz Similar Extent Arithmetic.

4 Empirical Analysis

The data in Empirical test is gained through 100 questionnaire (39 % of them are valid) and interviews with 20 experts. Samples are mainly the developed cities in China, such as Shanghai, Beijing, and Shenzhen and so on. The respondents work in 10 securities research institutions or HR department from CICC, SW Securities, Everbright Securities and other securities corporation.

4.1 Basic Evaluation

From respondents' demographic information, they have high degrees and rich work experience. This provides a guarantee for the reliability of the survey results.

Table 2 shows managers' evaluation on securities analysts' competence. In terms of knowledge and work experience (u_1), more than 70 % of respondents think that securities analysts' education and qualifications/certificates are 'good' but the other three aspects are 'average'. In terms of working capability (u_2), nearly 40 % of respondents hold positive opinions on securities analysts' logical thinking while most people give neutral evaluation on other four capabilities. In terms of job performance (u_3), most people think Securities Analysts' job performance is average even bad. In terms of moral and characteristics (u_4), more than 30 % of respondents say that securities analysts have good ethics and emotion management, but less than 50 % of respondents think that they perform average in the other aspects. Generally speaking, securities analysts are incompetent. Especially they perform worse in providing objective and true research report, forecasting accurately and reliably, holding innovative consciousness and independent opinion. This paper concludes that the comprehension quality of domestic securities analysts should be further elevated.

4.2 Fuzzy Comprehensive Evaluation

Through Delphi method, we get the weighting value as follows:

$$
\begin{aligned}
A &= (0.25, 0.25, 0.3, 0.2)\\
\mathrm{A}_1 &= (0.3, 0.2, 0.1, 0.2, 0.2)\\
\mathrm{A}_2 &= (0.2, 0.2, 0.2, 0.1, 0.3)\\
\mathrm{A}_3 &= (0.3, 0.3, 0.2, 0.2)\\
A_4 &= (0.25, 0.15, 0.15, 0.2, 0.15, 0.1)\,.
\end{aligned}
$$

Table 2 Basic evaluation result unit: %

Indicator		Result				
		Worse	Bad	Average	Good	Excellent
u_1	u_{11}	0.00	3.09	5.56	77.16	14.20
	u_{12}	0.00	8.64	72.22	15.43	3.70
	u_{13}	0.00	6.17	75.93	8.64	9.26
	u_{14}	0.00	3.09	7.41	83.33	6.17
	u_{15}	0.00	8.02	80.25	10.49	1.23
u_2	U_{21}	6.17	7.41	51.85	32.10	2.47
	U_{22}	3.09	9.88	69.75	16.05	1.23
	U_{23}	4.94	6.17	33.33	38.89	16.67
	U_{24}	9.26	26.54	46.30	14.81	3.09
	U_{25}	11.11	19.75	49.38	10.49	9.26
u_3	U_{31}	26.54	18.52	41.98	9.26	3.70
	U_{32}	23.46	22.22	27.78	15.43	11.11
	U_{33}	17.28	25.31	43.21	6.17	8.02
	U_{34}	12.35	16.05	34.57	27.78	9.26
u_4	U_{42}	19.75	5.56	18.52	33.95	22.22
	U_{42}	14.20	9.26	42.59	21.60	12.35
	u_{12}	9.26	20.37	45.68	13.58	11.11
	U_{43}	22.22	35.19	35.80	3.70	3.09
	U_{44}	13.58	12.35	37.04	29.01	8.02
	U_{45}	4.94	12.35	15.43	38.89	28.40

According to Table 2, we get the first-level evaluation matrix:

$$
\begin{aligned}
B_1 &= A_1 * R_1 = (0, 0.0549, 0.4123, 0.4586, 0.0741)\\
B_2 &= A_2 * R_2 = (0.0710, 0.1327, 0.5043, 0.2204, 0.0716)\\
B_3 &= A_3 * R_3 = (0.2093, 0.2094, 0.3648, 0.1420, 0.0790)\\
B_4 &= A_4 * R_4 = (0.1543, 0.1596, 0.3213, 0.2275, 0.1373)
\end{aligned}
$$

Then, we get the second-level evaluation matrix:

$$
\begin{aligned}
B &= A * R = (0.25, 0.25, 0.3, 0.2) *\\
&\begin{bmatrix} 0 & 0.0549 & 0.4123 & 0.4586 & 0.0741\\ 0.0710 & 0.1327 & 0.5043 & 0.2204 & 0.0716\\ 0.2093 & 0.2094 & 0.3648 & 0.1420 & 0.0790\\ 0.1543 & 0.1596 & 0.3213 & 0.2275 & 0.1373 \end{bmatrix}\\
&= (0.1114, 0.1403, 0.4029, 0.2578, 0.0876)
\end{aligned} \tag{15}
$$

Fuzzy Comprehensive Evaluation shows securities analysts' average performance (0.4029), based on the Maximum Fuzz Similar Extent Arithmetic.

5 Conclusion and Policy Suggestion

The results show that securities analysts are incompetent as a whole. Especially they perform worse in "forecast accuracy", "forecast objectivity", and "innovation and independence". This paper concludes that the comprehensive qualities of domestic securities analysts should be further enhanced.

To further improve the securities analysts' capability and skills in China, this paper provides the following four suggestions.

First, maintain the order of securities market through building individuals' work ethics, improving their independence and objectivity, enhancing resistance to stress and self-control.

Second, HR directors should pay more attention to selection and training of securities analysts. They also need to provide a better research environment, and supervise securities analysts' work ethics

Third, domestic securities regulatory authorities should strengthen the legal system design. They can learn from regulations from other countries, for example, fair disclosure; message audit and information isolation should be enhanced to curb the conflict of interests.

And last, third-party should participate into the competence evaluation of securities analysts. Some shady deal and offence against law can be disclosed through media coverage. For example, *China Times* and *Financial Weekly* has provided reports on some incompetent securities analysts. Media coverage will be beneficial to the order of stock market and protect investors' interests.

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The Value at Risk Measure of the Yuan Against the Dollar

Guang-lai Zhou, Cui Lu, Bei-bei Qi, and Li Shang

Abstract In this article, we combined the methods of AR-GARCH and History Monte Carlo, with which we measured the exchange rate risk of the RMB. We mainly used AR-GARCH model to simulate and estimate the time series of the RMB exchange rate, with which we solved the problem of conditional heteroscedasticity, and get the residual series with zero mean, conditional heteroscedasticity and the conditional mean series and the autoregression equation, then which is used to be the basis of Monte Carlo simulation method to measure the value of the RMB exchange rate risk. The results show that this combination of both can effectively solve the problems of peak and fat tail in residual series, non-normality and caused error by estimating the parameters of the fitted distribution, and can effectively improve the credibility and accuracy of measurement of the exchange rate value at risk.

Keywords Exchange rate • Measure • Value at risk

1 Introduction

According to statistics, since exchange rate (Meng-Long Shih et al. 2008) reform from 1994 to the end of September 2011, the RMB against the dollar have appreciated cumulatively by 36.9 %. Calculated by caliber of bank for international settlements, up to the end of August 2011, the nominal and real effective exchange rate of the RMB against the major trading partners appreciate cumulatively by 33.4 % and 58.5 %, respectively. The increasing flexibility of the RMB exchange rate means that exchange rate impacts on Chinese economy more uncertainty. The

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widespread financial risk in 2008 and its great harm warn Chinese enterprises attention to the exchange rate value at risk.

Leptokurtic heavy tail (Creal et al. 2011) feature led to the problem that the residuals series of time series don't meet the normal distribution, in practice, this means that a random sample from such a distribution will have more extreme values, kurtosis of the normal distribution K(x) = 3, so K(x)-3 called as excess kurtosis, therefore, if a certain distribution has a positive excess kurtosis, then this distribution has a fat tail, the thick tail means that the distribution has more "quality" in its tail than that of the normal distribution. If we use the normal distribution to estimate the value at risk, it will cause the under pricing of risk. In this regard, many scholars at home and abroad solve it by using t distribution (Wang Meijin and Wang Hua 2002), GDM distribution (Liu Qingfu et al. 2007), mixed normal distribution (Zheng Yuhua and Cui Xiaodong 2009), the distribution of Brownian motion (Zhou Ying and Wu Zhehui 2007), Bayesian time-varying quantile forecasting (Gerlach et al. 2011), TGARCH (Xiaojia Wang 2013), combinatorial copula function (Chen Lin and Zhou Zongfang 2009) and so on, but these methods inevitably bring in some errors by fitting the distribution parameters estimation. So, in order to solve the problems all above, we propose a new method measuring the exchange rate value at risk to address the leptokurtic and fat tail problem, which is the combination of the AR-GARCH model and Monte Carlo simulation method.

2 Background and Proposed Method

2.1 VaR (Value at Risk) Theory

VaR (Jory 2010) means that, at a certain confidence level, financial assets (or portfolio) will have the potential loss of a specific time in the future. The mathematical idea is as follows:

If X Represents a random loss, $F_x(x)$ is the distribution function of X. VaR means that under a given significant level $\partial \in (0,1)$, the greatest possible loss is $P_r\{X \le VaR_\partial(X)\} = \partial$, that is $VaR_\partial(X) = F_X^{-1}(\partial)$. Among which $F_X^{-1}(\partial)$ expressed quantile fractile at the significant level ∂ that is the value-at-risk. The generated VaR is the product of JP Morgan Company which is used to measure the market risk. Different means from that of measurement of traditional risk, VaR is a risk measurement technique, which is absolutely based on the statistical analysis.

The VaR calculations usually need to consider three factors: the size of the confidence level, length of the holding period, and the characteristics of the distribution of the return on future assets. Its key is the distribution of Yield. How to accurately describe it and estimate the yield distribution characteristics, especially that of the tail, which is key influencing factors to accurately define the VaR value (Tsay 2009).

2.2 AR-GARCH Model

GARCH (Nelson 1990) model has a requirement for residual series $\{\varepsilon_t\}$: $\{\varepsilon_t\}$ is a sequence with zero mean and pure random and heteroscedasticity. But sometimes regression function $f(t, x_{t-1}, x_{t-2}, \ldots)$ cannot fully extract the information in the original series, and residual series may be relevant, rather than random. To solve the problem at this time, first, we need to fit from the autoregression model, and then consider homogeneity of variance of autoregressive residuals sequence $\{\eta_t\}$, If $\{\eta_t\}$ is heteroscedasticity, then we use GARCH model to fit it, such a tectonic model as the AR(m)-GARCH(p,q) model. Considering the heteroscedasticity and related issues of residual series, we use AR(m)-GARCH(p,q) model (Wang Yan 2005).

2.3 History Monte Carlo Simulation Method

Monte-Carlo simulation method is the most effective method to measure the VaR up to date, the method is very flexible and can include time-varying variance or expected revenue, fat tail and extreme cases and so on, the actual value of the data can be approximated through Repeating simulation of the original data. Here, we use the history Monte-Carlo simulation method to calculate the VaR of the exchange rate. This method differs from the general Monte-Carlo simulation method selecting the random variable from the hypothetical distribution, but it selects from the historical data sample, because the future data and the data is similar, including the environmental impact of data changes, so do may be more in line with the actual situation.

Step 1 The random number generated, along with residual series of the conditional mean of the exchange rate coming from the historical data constitute the sampling set $\{\eta_t\}$, then each of random sample from the space takes a sample of data; Step 2 Use sample to generate pseudo-random variables $\varepsilon_1, \varepsilon_2, \ldots \varepsilon_n$, and then by a formula:

$$\mu_{t+i} = \varphi_1\mu_{t+i-1} + \varphi_2\mu_{t+i-2} + \varphi_3\mu_{t+i-3} + \varphi_4\mu_{t+i-4} + \varepsilon_i \quad (i = 1, 2, \cdots n)$$

to get the conditional mean sequence $\mu_{t+1}, \mu_{t+2}, \ldots \mu_{t+n}$ of RMB exchange rate (Wann-Jyi Horng and Chi-Ming Kuan 2009) and the final value of the conditional mean sequence; Step 3 Calculate the final value of the target time T, getting the conditional mean sequence $\mu_{t+n} = \mu_T$ of RMB exchange rate; Step 4 Repeat the second and third step m times, resulting in the distribution of the conditional mean of the RMB exchange rate. The quantile fractile ∂ of the distribution calculated based on the distribution is called VaR.

2.4 Monte Carlo Simulation of the Exchange Rate Risk Based on AR-GARCH Model

In the process of simulation and estimation using AR-GARCH model to fit the exchange rate time series, often exists leptokurtic heavy tail of residual sequence. The result is that the assumption of the AR-GARCH model residual series does not follow normal distribution. To this end, we will combine AR-GARCH model and the Monte Carlo model to get the improved method and steps.

First, AR-GARCH model estimation, get the autoregression equation of the conditional mean sequence $\mu_t = f(\mu_{t-1}, \mu_{t-2}, \cdots, \mu_{t-n}) + \eta_t$. And calculate the residual series $\{\eta_t\}$ of historical sample. Second, generate random numbers, random sample from a sampling set constituted by residual series $\{\eta_t\}$, each taking a sample of data. Third, generate pseudo-random variables $\varepsilon_1, \varepsilon_2, \ldots \varepsilon_n$, and then by a formula:

$$\mu_{t+i} = \varphi_1 \mu_{t+i-1} + \varphi_2 \mu_{t+i-2} + \varphi_3 \mu_{t+i-3} + \varphi_4 \mu_{t+i-4} + \varepsilon_i \quad (i = 1, 2, \cdots n) \tag{1}$$

Get the conditional mean sequence of RMB exchange rate $\mu_{t+1}, \mu_{t+2}, \ldots \mu_{t+n}$. Fourth, calculate the final value of the target time T; get the conditional mean sequence of RMB exchange rate $\mu_{t+n} = \mu_T$. Fifth, repeat the third and fourth steps m times, resulting in the distribution of the conditional mean of the RMB exchange rate. According to the distribution, calculate the quantile fractile ∂ of the distribution, which is VaR.

3 Measures Validation and Results

3.1 Sample Selection and Data Sources

Because the exchange rate of RMB against the dollar is at the core of the foreign exchange market in China, their changes will all impact the economic entities of all levels in China. It becomes a priority to study the risk of fluctuations in the exchange rate of the RMB against the dollar naturally. In view of several major reforms of the RMB exchange rate formation mechanism since July 21, 2005. As well as the impact of the financial crisis since 2008, we have chosen a broader data to reduce the impact of special events and improve stability of the data. So, we select the central parity of yuan against the dollar from August 1, 2005 to September 30, 2012 as the sample of data analysis, a total of 1,743 samples of observations. These data are derived from the People's Bank of China possessing higher authority (*Sample sources:* http://www.pbc.gov.cn/publish/zhengcehuobisi/637/index.html).

Table 1 AR-GARCH model parameters estimation

GARCH estimate			
SSE	622.120055	Observations	1,747
MSE	0.35611	Uncond VaR	.
Log likelihood	−842.48614	Total R-square	0.9999
SBC	1744.69753	AIC	1700.97228
Normality test	298.6866	Pr > ChiSq	<0.0001

Table 2 AR-GARCH model parameters estimation

Variable	DF	Estimate	Standard error	t Value	Approx Pr > |t|
Intercept	1	634.5588	1.5054	421.52	<.0001
AR1	1	−1.0477	0.0229	−45.69	<.0001
AR2	1	0.0732	0.0300	2.44	0.0146
AR3	1	−0.1066	0.0288	−3.71	0.0002
AR4	1	0.0810	0.0207	3.91	<.0001
ARCH0	1	0.0000123	7.7094E−6	1.60	0.1099
ARCH1	1	0.2105	0.0102	20.63	<.0001
GARCH1	1	0.8096	0.005781	140.05	<.0001

3.2 Selecting Basis and Given Order of AR-GARCH Model

The time series of exchange rate of the RMB against the dollar have characteristics: non-stationarity, conditional heteroscedasticity, autocorrelation, non- white noise and so on. It suggests that we can use the time-series model to simulate and estimate the time series of exchange rate of the RMB against the dollar, but the AR model and ARCH model does not apply to it, so we select the AR-GARCH model.

After several times of fitting AR-GARCH model, considering the AIC criteria and SBS criteria and Total R -Square in Table 1, the goodness of fit of the model parameters in Table 2, we have adopted the AR(4)-GARCH(1,1) model, fitting results shown in Fig. 1, you can visually see that the fitting effect is very good, but by the normality test $p < 0.0001$ in Table 2, we should reject the null hypothesis (H_0: normality exists), so the residual series does not follow a normal distribution, we need to improve the AR-GARCH model.

Among them, X represents central parity of exchange rate of RMB against the dollar; starting time from the September 30, 2012.

3.3 Monte Carlo Simulation Model's Specific Operation Based on AR-GARCH

Step 1. Estimation of AR(4)-GARCH(1,1) model's parameters.

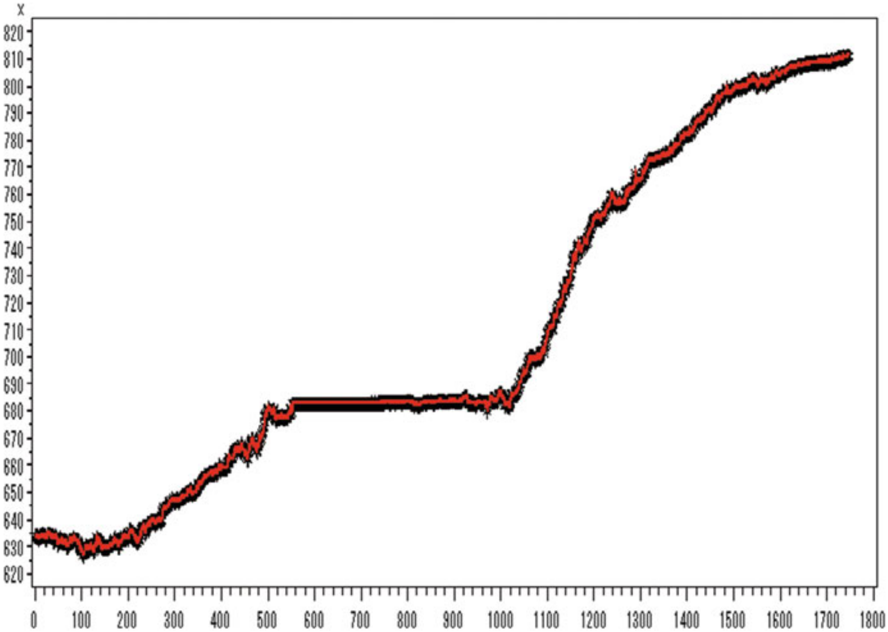

Fig. 1 The fitting effect AR(4)-GARCH(1, 1) model *black* '*star*' for raw data graphics, *red* '*line*' for fitting data graphics (Color figure online)

In view of the history Monte-Carlo simulation method, it mainly simulates and estimates the potential loss of the RMB exchange rate by means of a large number of historical data. Although it is widely used in practice, the assumptions of its consistency on historical data have ignored the combined effect, the thick tail effect, time-varying variance effect of the distribution of the RMB exchange rate. Therefore, we use the AR-GARCH model to process the conditional mean of residual series $\{\eta_t\}$, in order to more accurately portraying the volatility and heteroscedasticity of the conditional mean of residual series, and provide more accurate data for the application of the history Monte-Carlo simulation to simulate the conditional mean μ_t, thereby better conform to the reality.

By the autoregression process of SAS system, we use conditional least squares method to estimate parameters (see Table 2), and get the model's caliber:

$$\begin{cases} x_t = 634.5588 + \mu_t \\ \mu_t = 1.0477\mu_{t-1} - 0.0732\mu_{t-2} + 0.1066\mu_{t-3} - 0.0810\mu_{t-4} + \eta_t \\ \eta_t = \sqrt{h_t}\upsilon_t, \upsilon_t \sim \mathrm{N}(0, 0.35611) \\ h_t = 0.0000123 + 0.2105\eta_{t-1}^2 + 0.8096h_{t-1} \end{cases} \quad (2)$$

We take the residual series as a time series $\{\eta_t\}$ with zero mean and heteroscedasticity.

The formulas of conditional mean and residual of the sample:

$$\mu_t = x_t - 634.5588 \tag{3}$$

$$\eta_t = \mu_t - 1.0477\mu_{t-1} + 0.0732\mu_{t-2} - 0.1066\mu_{t-3} + 0.0810\mu_{t-4} \tag{4}$$

But the residual series $\{\upsilon_t\}$ does not follow a normal distribution, we combined the model above with Monte Carlo simulation to measure VaR and test the effects.

Step 2. AR(4)-GARCH(1, 1) model combined with Monte Carlo simulation to measure VaR.

Taking into account the inevitable sampling error in the simulation of the time, it is subject to restrictions on the sample and the times of simulation and which results in differences of estimations, but more repetitions can get a more accurate estimate. Therefore, in order to obtain efficient and accurate data, we simulated 10,000 data (completed by MATLAB software programming).

First, to calculate historical sample of the residual series $\{\eta_t\}$ and the conditional mean series $\{\mu_t\}$ from AR(4)-GARCH(1,1) model, we randomly select 100 pseudo-random variables ε_i $(i = 1 \ldots 100)$ from the residual series.

Second, 100 simulation values of the conditional mean obtained by the formula:

$$\mu_t = 1.0477\mu_{t-1} - 0.0732\mu_{t-2} + 0.1066\mu_{t-3} - 0.0810\mu_{t-4} + \eta_t \tag{5}$$

And the initial value of simulation is sample conditional mean of the last 4 days, then get the final value of the future target period T.

Third, simulate 10,000 times by Monte Carlo simulation, and get the distribution of the simulation value of the conditional mean: $\mu_T^1, \mu_T^2, \cdots \mu_T^{10000}$

According to the quantile fractile of experience distribution, we calculated that the maximum possible VaR were 0.6082, 0.8604, 1.6274, respectively, under the significance level of 10 %, 5 %, 1 %.

3.4 Checking the Results of Measurement

The accuracy of the VaR can be evaluated by the test method based on the failure rate. There are T samples in a given T time window, if we define the number of failure as N which is the number of sample values over the predictive value of the corresponding period of the sample, that is, the number of abnormal samples, and then larger in the T, N should be close to the T $(1-\alpha)$, and the failure rate is N/T, where α is the confidence level. We use the method which is proposed by Kupiec (1995) to build the log-likelihood ratio statistic:

$$\mathrm{LR} = -2\ln\left[(1-\alpha)^{\mathrm{T-N}}\alpha^{\mathrm{N}}\right] + 2\ln\left[(1-\mathrm{N/T})^{\mathrm{T-N}}(\mathrm{N/T})^{\mathrm{N}}\right] \tag{6}$$

Table 3 Results of VaR test

Confidence	T = 1,743 day (failure rate, LR values)	Non-rejection region of LR
$\alpha = 90$ %	Failure rate = 0.078026, LR = 10.03811	(0.003932, 3.8414591)
$\alpha = 95$ %	Failure rate = 0.039013, LR = 4.775885	(0.000982, 5.023886)
$\alpha = 99$ %	Failure rate = 0.006311, LR = 2.757384	(0.000039, 7.879439)

By the above Table 3, under the significance level of 10 %, the LR value is in the rejection region, and LR = 10.03811 > 3.8414591, this shows that under the significance level of 10 %, the measurement of value at risk is a bit high, but under other significance levels, LR value is in the non-rejection region. Therefore, the VaR has very good accuracy and credibility at the significance levels of 5 and 1 %.

4 Conclusions

The empirical results show that, although VaR is estimated a bit high under the significance level of 10 % through simulating VaR of exchange rate by history Monte Carlo simulation based on the AR-GARCH model, it has good reliability and accuracy under the significant level of, respectively, 5 % and 1 %. To some extent, it solved the problems in the conditional heteroscedasticity and the leptokurtic heavy tail feature of residual series of the RMB exchange rate, and avoided error estimating parameters of fitted distribution, and solved the issue that the assumption that history can repeat itself can't satisfy the reality in historical simulation method, and improved the credibility and accuracy of measurement of VaR overall. Although we verified the effect of measurement VaR of the exchange rate on base of the AR-GARCH model and Monte Carlo simulation through empirical, but the actual operability remains to be further inspection.

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Does Investor Sentiment Have Certain Impacts on IPO Underpricing Rate?

Song Wang and Yao Yao

Abstract High IPO underpricing is a major feature of China's stock market and adequate studies of this issue have been made based on the traditional efficient market hypothesis, whereas using behavioral finance to study IPO underpricing is still a new topic.

We employ 60 GEM IPO companies listed between Oct 30th 2009 and Mar 19th 2010 as samples, and analyze the impact of investor behavior on IPO underpricing based on investor sentiment supported by behavioral finance theory. According to our research, the price of the new stocks on the first day is more likely to be overestimated with higher investor sentiment, which generates a higher IPO underpricing rate.

Keywords Behavioral finance • Investor sentiment • IPO underpricing • Listed companies

1 Introduction

IPO underpricing refers to the phenomenon that the issue price of a stock in the primary market is lower than its first-day closing price on the secondary market, which results in the abnormal return of the new stock on the first day.

With GEM as an emerging market, the stock price in GEM is more likely to be affected by investor behavior than the main board. Therefore, this paper narrows the

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subject into a more specific one, that's to analyze the impact of investor behavior on IPO underpricing based on investor sentiment in GEM.

The investor sentiment concept in behavioral finance can be used to study the phenomenon that the asset price deviates from the equilibrium value due to irrational cognitive and behavior. Results from De Bondt and Thaler (1985) show that (De Bondt and Thaler 1985), people tend to be too confident when making decisions about uncertain affairs. Tversky and Kahneman (1973) pointed out that (Tversky and Kahneman 1973), when people make decisions on such affairs, they usually focus only on single feature and compare it to another similar and typical event for analogy and inference, leading to cognitive biases. Lord et al. (1979) found that when people formed certain believes (Lord et al. 1979), they no longer care about new information, instead, they adhere to their existing believes, thus causing the so-called 'Information Curing' phenomenon. Langer (1975) thought that people tend to owe those favorable contributions to themselves and unfavorable ones to external causal factors (Langer 1975). All the factors mentioned above effect alternately during the IPO pricing process, each playing an important role in IPO underpricing.

Ritter and Welch (2002) explained IPO underpricing with investor sentiment and he suggested that IPO underpricing has a significant correlation with the market sentiment (Ritter and Welch 2002). Kang, Kim and Stulz (1999) believed that investors often have high expectations for the IPO companies resulting in a lack of response to negative news and an overestimation of new stocks (Kang et al. 1999). Cornelli and Goldreich (2001) found that the demand caused by high investor sentiment is widespread (Cornelli and Goldreich 2001) which has a so great impact on the IPO market that investors have to pay extremely high premium.

We can conclude from previous research that adequate studies of traditional IPO underpricing theory have been made based on the traditional efficient market hypothesis, whereas using behavioral finance to study this issue is still a new topic.

2 Methodology

2.1 Hypothesis

This paper mainly analyzes the impact of investor sentiment on IPO underpricing. Previous research has shown that high sentiment may lead to irrational behavior like overreaction, herding and cause overestimation of asset price, indicating that investor sentiment is regarded as an important behavioral factor (Benveniste and Busaba 1997). Therefore, we raise our hypothesis based on the analysis above:

H1: the price of the new stocks on the first day is more likely to be overestimated due to higher investor sentiment, generating a higher IPO underpricing rate, which means that the degree of investor sentiment is positively correlated with IPO underpricing rate.

2.2 Variables

The variables involved in our research include explained variables, explanatory variables and control variables, with IPO underpricing rate serving as the main object and explained variable, proxy variables of investor sentiment the explanatory variables and characteristic corporate and market factors, which may have impact on IPO underpricing, the control variables. The following part will make detailed explanations about the structure and selection of those variables. We then build regression model used to test this hypothesis after setting all the variables we need.

2.2.1 Explained Variables

The explained variable in this paper is IPO underpricing rate (IR) used to measure the degree of IPO underpricing. Its equation is:

$$IR = \frac{P_1 - P_0}{P_0} \times 100\ \% \tag{1}$$

P_1 refers to the closing price on the first day of issue and P_0 refers to the issue price.

2.2.2 Explanatory Variables

This paper selects indicators directly related with IPO process to measure the degree of investor sentiment towards new stocks. According to previous research (Garfinkel and Sokobin 2006) and the unique features of China's GEM, we select online lot winning rate and listing batch as the proxy variables to measure the degree of investor sentiment.

1. *Lot winning rate*

   Lot winning rate is the ratio of online circulation to the effective online amount of purchase (Baker and Wurgler 2006), which measures investors' expectation and demand for IPO stocks. Low lot winning rate indicates that investors have optimal expectation towards the issuing company with more demand for its new stocks. With unmet needs for the new stock in the primary market transferred to the secondary market, its price will be raised in the secondary market, bringing investors abnormal return on the first day (Harrison and Kreps 1978). Therefore, lot winning rate can measure the investor sentiment in the new stock market in a relevantly proper way, so it should be negatively correlated with IR.

2. *Listing batch*

   Issuing stocks in batches for IPO is a unique feature of China's GEM (Weiqin et al. 2006). With 28 companies in total, there are most companies in the first batch. Since GEM is still an emerging market in China and Chinese investors tend to be especially enthusiastic about anything new, it's reasonable to predict that investors will show more interest in previous batches than in subsequent ones (Wei and Yongjie 2006). Therefore, this paper uses listing batch as another indicator for investor sentiment.

After selecting lot winning rate and listing batch as explanatory variables, we can convert the hypothesis into the following two sub-propositions:

H1a: Lower lot winning rate will lead to the higher possibility for the closing price to be overestimated on the first day and finally cause the higher IR, so lot winning rate has negative correlation with IR.

H1b: Greater value of listing batch will lead to the higher possibility for the closing price to be overestimated on the first day and finally cause the higher IR, so listing batch has positive correlation with IPO underpricing rate.

2.2.3 Control Variables

Factors influencing IR can be divided into three parts: corporate factors, market factors and behavioral factors (Yixia and Hui 2009). Since behavioral factors are the main study objects in this research, we should choose certain representative corporate and market factors as control variables to reduce their influences on IR.

1. *Logarithm of total market value*
   The total market value is equal to the product of the total number of shares after issue and the issue price, which is used to measure the size of the listed company.
2. *ROE in the last year before issuing*
   ROE indicates the profitability of the company (Sherman and Titman 2002). Satisfying profitability can enhance its investment value, so it has positive influence on IR.
3. *Average growth rate of main business in the last 2 years before issuing*
   This rate indicates the revenue growth of the company and predicts its potential for future development to some extent.
4. *Ranking of the leading underwriter*
   Leading underwriter with high ranking usually has better reputation (Loughran 1994). This paper sets ranking of the leading underwriter as dummy variable, setting top ten as 1 and others as 0 according to the ranking for main underwriting amount of stock brokers made by the Securities Association of China in 2009.

To sum up, all the explained variables, explanatory variables and control variables in this paper can be concluded as follows:

The empirical part of this paper intends to adopt the multiple linear regression method to test the correctness of the hypothesis. We build the following regression model based on theoretical analysis and variables set (Table 1):

Table 1 Summary of variables in the paper

Name	Symbol	Definition
Explained variable		
IPO underpricing rate	IR	(Closing price on the first day of issue-issue price) ÷ issue price × 100 %
Explanatory variable		
Lot winning rate	Lottery	Online circulation/online effective amount of the purchase × 100 %
Listing batch	Batch	Dummy variable. that before the median of sample is set for 1 and others for 0
Control variable		
Logarithm of total market value:	LnValue	Ln (the product of the total number of shares after issue × issue price)
Return on equity	ROE	Ratio of net profit in the last year before issuing to the stockholders' equity
Growth rate of main business	IncomeGro	Average growth rate of main business in the last 2 years before issue
Ranking of the leading underwriter	Rank	0–1 variable. That of top ten is set for 1 and others for 0 according to the ranking for main underwriting amount of stock broker made by the Securities Association of China in 2009

$$IR = \beta_1 Lottery + \beta_2 Batch + \beta_3 LnValue + \beta_4 ROE + \beta_5 IncomeGro + \beta_6 Rank + \varepsilon \tag{2}$$

2.3 Data

All the data including IPO underpricing rate, lot winning rate, listing batch, total market value and return on net assets used in this study is directly downloaded from the CSMar database. We choose 356 samples in total, covering all the IPO companies in GEM before Oct 2012.

3 Results

Based on the model built in this paper, we adopt the multiple linear regression method to verify the three hypothesizes proposed above.

First, we use forced entering strategy to make regression analysis, that's to put every single independent variable into the regression equation. And the regression results are shown in Tables 2, 3, and 4:

According to the significance of each regression coefficient, 'lottery' and 'batch' have significant linear correlation with explained variables, well verifying the two

Table 2 Test of goodness-of-fit of the forced regression equation

R	R^2	Adjusted R^2	The standard error of the estimation
0.913	0.834	0.796	20.73309

Table 3 Analysis of variance in forced regression

	Variation	Degree of freedom	Variance	F value	Significance
Explained variation	56,553.852	6	9,425.642	21.927	.000
Unexplained variation	150,021.489	349	429.861		
Total variation	206,575.341	355			

Table 4 Analysis of variance in forced regression

Category	Name	Regression coefficients	T value	Significance
Explanatory variables for investor sentiment	Lottery	−74.798***	−5.160	.000
	Batch	47.842***	3.613	.001
Control variable	LnValue	6.981	1.022	.312
	ROE	−.351	−1.600	.116
	IncomeGro	.066	1.477	.146
	Rank	2.346	.359	.721
Intercept	Constant	−232.250	−1.453	.153

***Indicates significance at the 1 % level

sub-hypothesizes in this paper. Since the seven control variables selected do not have significant linear correlation with IR, we can infer that the performance of new stocks in the GEM on its first day is not highly influenced by corporate and market factors. Considering that only the R^2 of behavioral factors in the regression equation is greater than 0.8, such factors can even be regarded as the deciding factors of IR for new stocks in GEM.

4 Discussion

There are two variables to measure the degree of investor sentiment: lot winning rate and listing batch. Both of them have significant linear correlation with IPO underpricing rate and their signs is consistent with our predictions, which verifies our hypothesis.

'Lottery' significantly has negative correlation with IR when it's lower than 1 %. We can conclude that low 'lottery' indicates that investors have optimal expectation towards the issuing company with more demand for its new stocks. With unmet needs for the new stock in the primary market transferred to the secondary market, its price will be raised, leading to an increase in IR. Therefore, the hypothesis H1a is verified.

Likewise, ‘batch’ significantly has positive correlation with IR when it’s bigger than 1 %. We can conclude that investors tend to show more enthusiasm in previous batches than in subsequent ones, leading to an increase in IR. So the hypothesis H1b is also verified.

Therefore, the two sub-propositions under the main hypothesis that ‘the degree of investor sentiment is positively correlated with IPO underpricing rate’ are both verified.

The six control variables selected in this paper have been proved to have significant influences on IR in lots of previous research, but they do not show the same results in this paper. The reasons shall be explained in various ways.

‘LnValue’ doesn’t have significant correlation with IR may because that the float caps of IPO companies in GEM are mostly so small that they will be overthrown by the huge market.

‘ROE’ and ‘IncomeGro’, variables to characterize the profitability and growth of companies, don’t have significant influence on IR, which means that investors do not make decisions about the investment in new stocks based on the fundamentals disclosed in the prospectus of the company and they mostly follow other investors to make irrational decisions.

‘Rank’ has the same result, suggesting that the reputation of underwriter doesn’t have significant influence on the issue price. Employing reasonable price to enhance reputation doesn’t have as great impact in China as that in developed countries for underwriters.

5 Conclusion

Based on behavioral finance, this paper intends to study the classic topic of IPO underpricing with a new perspective. This paper uses all the IPO companies from the establishment of GEM in China as samples and choose two reasonable proxy variables for investor factors to verify the hypothesis that ‘the degree of investor sentiment is positively correlated with IPO underpricing rate’. The result shows that Chinese investors tend to be overconfident and are likely to irrationally follow other investors, showing too much enthusiasm for new stocks in GEM, resulting in the severe problem of stock price being overestimated on the first day. Meanwhile, corporate factors and market factors do not have significant influence, which indicates that investors consider little about the rational factors when investing in new stocks in GEM and the phenomenon of IPO underpricing in China’s GEM is mainly due to the irrational behavior in the secondary market.

But we have to admit that our research does have some limitations. We select two variables to serve as proxy indicators for behavioral factors, so there must be certain bias in terms of the number of variables and their appropriateness. We hope that we can find more behavioral factors serving as more appropriate proxy variables in our further study to better analyze the impact of behavioral factors on the security market price in China.

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A Study on Similar Financial Model in Real Estate Sector

Yi-chun Li

Abstract In this paper, we subdivide the sample of real estate listed companies selected from the two stock exchanges in China from the year 2001–2012 into two categories: firms which adopted the similar financial model and firms which did not adopt. T-tests and nonparametric tests are used to explore the differences between the two categories in funds management, assets structure, liability structure, profitability, liquidity and growth rate. The results show that firms which adopted the similar financial model have faster assets turnover and higher Debt Ratio (DR), thus have higher growth rate and better profitability. The regression analysis results further show that Return on Invested Capital (ROIC) of similar-financial-model firms are significantly correlated with Net Profit Margin (NPM) positively and with the Ratio of Net Commercial Credit to Sales Revenue (NCCSR), Cash Conversion Cycle (CCC), Financial Expense Ratio (FER) and the Ratio of Interest–bearing Liabilities to Debt (IBDR) negatively. Moreover, negative relationship between ROIC and GROUP demonstrates that firms which adopted similar financial model have better profitability than firms which did not adopt.

Keywords Liquidity risk • Profitability • Real estate sector • Similar financial model

1 Introduction

In recent years, the similar financial model is widely appearing in retail-chain industry, household appliance manufacturing industry and real estate industry. Hong-guang Wu and Ling Li first proposed the “similar financial” survival model

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within Gome and Suning (Hong-guang Wu and Ling Li 2005). They process cash transactions with consumers, while deferring payment to upstream suppliers, which gain a large number of floating cash on book. This survival model helps Gome and Suning achieve expansion of scale and become lucrative in the meanwhile. Dong-mei Wang and Ben-fu Lv considered that similar financial model essentially belongs to the management of commercial credit and commercial debt in working capital (Dong-mei Wang and Ben-fu Lv 2010). John Colina pointed out that working capital management consists of three parts: revenue management, supply chain management and the expenditure management (Colina 2002). There is also a strong relationship between working capital management and profitability (Gill et al. 2010). According to Hyun-Han Shi and Luc Soenen (1998), Cash Conversion Cycle (CCC) is negative correlated to Return on Equity (ROE), which is similar with Marc Deloof's opinion (Deloof 2003). Ning-ning Kong, Xin-min Zhang and Juan Lv found out that corporate profitability is negative correlated to Cash Conversion Cycle (CCC) (Ning-ning Kong et al. 2009). Fisman R and Love I also pointed out that the modern concept of working capital management pays more attention to using other people's money to meet its own needs of production and operation activities (Fisman and Love 2003; Fisman 2001). However, the previously ended Wong Kwong Yu case and the Gome crisis have warned people of the hidden risk in this survival model in Shi-zhong Huang (2006). Therefore, we need to find out what kind of impact the model may have on the enterprise's earning capacity and risk level. Most of the current researches are cases studying and mainly focusing on the discussions of particular similar financial survival model like Gome and Suning. To deeply study this model, large numbers of samples need to be applied for empirical analysis. However, this kind of article is barely seen at the moment.

In this article, we take all the A share real estate corporations that were listed in Shanghai and Shenzhen Stock market during year 2000–2012 as samples to study the characteristics of profitability and risk level of similar financial in real estate industry. One reason for choosing the real estate industry is that the real estate industry has natural "similar financial" model (Sai Ding et al. 2013). Owing to the strong demand of the real estate market and the fierce competition in construction industry, house buyers who are in weak position have to accept the forward house delivery methods. Also construction enterprises have to undertake the construction contracts through cash advancing paid. Thus real estate developers gain a lot of costless capital through occupation of these advance payment in cash. Another reason is that there are large numbers of listing corporation in this industry. Sample size is uniformly distributed to stand out as a good representative. Also there is a balance between similar financial implemented companies and non-similar financial implemented companies in this industry to ensure the sample adequacy of the experimental group and the control group for empirical analysis and the accuracy of the results. Finally, most of the previous researches are qualitative analysis on retail chain industry instead of real estate, empirical analysis based on Chinese market is hardly seen.

2 Methodology

2.1 Sample Selection

In this article, we take all the A share real-estate corporations that were listed in Shanghai and Shenzhen Stock market during year 2000–2012 as samples to study the characteristics of profitability and risk level of similar financial in real estate industry. The principles in choosing samples from all listed A share real estate companies in Shanghai and Shenzhen stock market from 2001 to 2012 are as follows:

1. Removal of ST companies from 2001 to 2012
2. Removal of financial and insurance companies
3. Removal of companies with obvious data error and key indicator absence
4. Removal of companies with 1 % abnormal turnover period and profitability indicator.

2.2 Indicator Selection

Among the many indicators reflecting company's profitability, we elect the rate of return on capital. This is because the index can better describe the profitability of financial enterprises (Chen and Chen 2012). Characteristics of similar financial enterprises are occupying more costless money and making less interest-bearing borrowings. Since Return on Capital = (Total Profit + Financial Expenses)/(Short-term Borrowings + Long-term Liabilities + Equity), it is considerably vulnerable to the influence of these characteristics.

2.3 Research Methodology

According to DuPont model, company's overall profitability is positive correlated to Net Profit Margin (NPM) and Debt Ratio (DR). Therefore the two variables needn't go through hypothesis test.

In addition, the shorter the Accounts Receivable Period (ARP) and Inventory Period (IP) and the longer the Accounts Payable Period (ARP) are, the easier the company is to repay commercial debt and to purchase extra raw materials to earn more profit. Thus we propose hypotheses 1.

Hypotheses 1: Return on Invested Capital (ROIC) is negative correlated to Cash Conversion Cycle (CCC).

The lower company's net commercial debt is, the more costless capital company will have, which lead to lower interest expenses and higher profitability. Therefore we propose hypotheses 2 and 3.

Hypotheses 2: Return on Invested Capital (ROIC) is negative correlated to Net Commercial Credit to Sales Revenue (NCCSR).

Hypotheses 3: Return on Invested Capital (ROIC) is negative correlated to Financial Expense Radio (FER).

Hypotheses 4: Return on Invested Capital (ROIC) is negative correlated to Interest-bearing Liabilities to Radio (IBDR).

Hypotheses 5: Similar financial model has a better performance over non-similar financial model.

$$ROIC = \alpha_0 + \alpha_1 GRSR + \alpha_2 NPM + \alpha_3 CCC + \alpha_4 NCCSR + \sum_{i=0}^{10} \alpha_{i+5} y_i + \varepsilon \tag{1}$$

$$ROIC = \alpha_0 + \alpha_1 GRSR + \alpha_2 NPM + \alpha_3 CCC + \alpha_4 FER + \alpha_5 DR + \sum_{i=0}^{10} \alpha_{i+6} y_i + \varepsilon \tag{2}$$

$$ROIC = \alpha_0 + \alpha_1 GRSR + \alpha_2 NPM + \alpha_3 CCC + \alpha_4 IBDR + \sum_{i=0}^{10} \alpha_{i+5} y_i + \varepsilon \tag{3}$$

$$ROIC = \alpha_0 + \alpha_1 GRSR + \alpha_2 NPM + \alpha_3 GROUP + \sum_{i=1}^{10} \alpha_{i+4} y_i + \varepsilon \tag{4}$$

$y_0 - y_{10}$ are dummies representing the year, while GRSR is the control variable.

NCCSR in (1), FER and DR in (2), IBDR in (3) have the same meaning, so we put them in three different models as substitute variable for each other. Similar finance model is defined by CCC and NCCSR, so we use GROUP in (4) as substitute variable for three variables mentioned before in the above models.

3 Results

3.1 Data Characteristics

According to the above on the definition of the type of financial model, this analysis studies number of real estate listed companies implementing the type of financial model in the 12 years which between 2001 and 2012, and draws the trend in Fig. 1. As shown in Fig. 1, the company accounted for the 2001–2012 12 years, the number

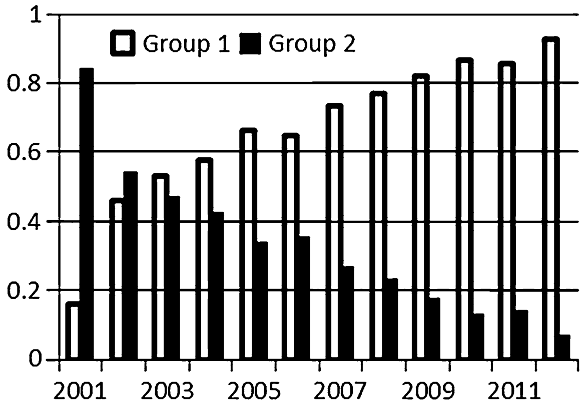

Fig. 1 Change of the number of similar financial model

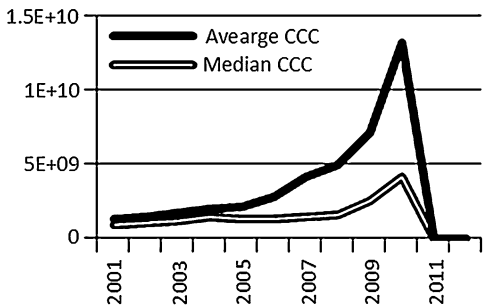

Fig. 2 Trend of CCC

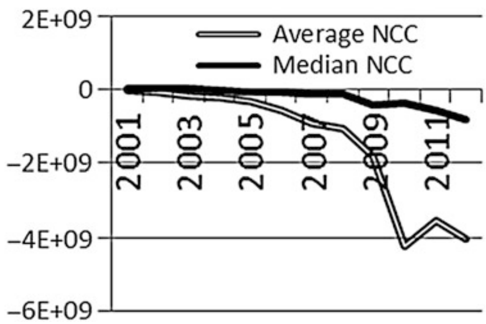

Fig. 3 Trend of NCC

of company implementing the type of financial model shows a steady upward trend, rising from 15.9 % in 2001 to 92.9 % in 2012, indicating that more and more companies were in the pursuit of this profit model.

In order to deeply explore the reasons for the change, the author further research the changes on CCC and NNC in the past 12 years, as shown in Figs. 2 and 3.

Overall, CCC and NCC basically showed a downward trend in 12 years, which indicates an increasing efficiency management of working capital. CCC claimed a little reversal change as well as NCC claimed a slight increasing (Zhu-quan

Table 1 The construction of assets and liabilities

Variable	Average			Median		
	Group 1 (%)	Group 2 (%)	T-test P value	Group 1 (%)	Group 2 (%)	Nonparametric tests P value
Monetary funds/current assets	18.95	20.11	0.000	15.51	14.68	0.000
Accounts receivable/current assets	4.41	12.26	0.000	1.17	7.46	0.000
Notes receivable/current assets	0.24	0.88	0.000	5.55	25.8	0.563
Short-terming borrowing/current liabilities	25.03	38.82	0.000	20.18	42.11	0.000
Accounts payable/current liabilities	14.56	12.00	0.000	12.09	8.82	0.000
Notes payable/current liabilities	2.09	2.66	0.000	37.16	17.00	0.000

Wang and Wen-jing Liu 2007). Zhu-quan Wang also found that working capital management performance in 2008 was significantly lower than in 2007 in 2/3 of the listed companies (Zhu-quan Wang et al. 2009; Zhu-quan Wang and Ning Liu 2010). The reason for the change was that Chinese economy had been significantly influenced by the financial crisis originated in the United States.

A specific analysis of the assets and liabilities construction of the two groups of companies can help to deeply find out the main source of financing and the situation of commercial debt and commercial business debt. As listed in Table 1, judging from the current assets, the proportion of commercial debt (accounts receivable + notes receivable, and prepayments) in group 1 on the monetary funds is greater than group 2. From a liability point of view, the proportion of commercial debt (accounts payable + notes Payable + prepayments) in group 1 is far greater than group 2. The difference in notes payable, short-term borrowings is significant between two groups. As shown in Table 3, the type of financial model has a high proportion of accounts receivable, low proportion of accounts payable, less proportion of short-term borrowings, while carrying more on the float more monetary funds.

As shown in Table 2, due to take up more commercial debt, less short-term borrowings and interest-bearing liabilities, group 1 has a lower financial cost. Meanwhile, group 1 has a lower net working capital, a shorter inventory turnover, and accounts receivable turnover, which indicates a high efficiency on working capital management in group 1 than group 2.

Table 2 The construction of period and assets turnover

	Average			Median		
			T-test			Nonparametric tests
Variable	Group 1	Group 2	P value	Group 1	Group 2	P value
NWC	18.95 %	20.11 %	0.000	15.51 %	14.68 %	0.000
NCCSR	–423.59 %	72.00 %	0.000	−37.49 %	18.47 %	0.000
FER	4.4568	19.3993	0.000	5.3218	3.6515	0.563
IBDR	55.6180	82.6457	0.000	26.10537765	34.02205363	0.000
IP	5806308050	1564123388	0.000	1965388421	647405789.8	0.000
ARP	3607522835	841650500	0.477	1324674260	458951267.1	0.000
APP	4137896853	798569549.9	0.000	1248456845	146738372.6	0.000
CCC	5275934032	1607204338	0.000	1968148969	897147439.1	0.000

Table 3 Regressions for ROIC

	ROIC			
	Model (1)	Model (2)	Model (3)	Model (4)
GRSR	−0.096***	−0.090***	−0.031***	−0.053***
NPM	−0.0004	−0.0003	0.000002	0.0004
CCC	−1.8723***	−0.141***	−2.2528***	
NCCSR	−0.0003***			
FER		0.00003		
DR		−1.908***		
IBDR			−0.0117***	
GROUP				−0.84***
Adjusted R Square	0.52	0.54	0.54	0.49

***Indicates significance at the 1 % level

3.2 *Results of Regression*

For space reasons, the result of regression on dummies is not listed in Table 3.

As shown in Table 3, the results show that firms which adopted the similar financial model have faster assets turnover and higher Debt Ratio (DR), thus have higher growth rate and better profitability. The regression analysis results further show that Return on Invested Capital (ROIC) of similar-financial-model firms are significantly correlated with Net Profit Margin (NPM) ($p < 0.01$) positively, Cash Conversion Cycle (CCC) ($p < 0.01$), Financial Expense Ratio (FER) ($p < 0.01$) and the Ratio of Interest–bearing Liabilities to Debt (IBDR) ($p < 0.01$) negatively. Moreover, negative relationship between ROIC and GROUP demonstrates that firms which adopted similar financial model have better profitability than firms which did not adopt.

4 Conclusion

The empirical result shows that the profitability of similar financial model has a better return on net assets and invested capital. At the same time, the debt service risk is also relatively larger. In general, we found that the lower the operating margin and net profit margin of sales of real estate listed companies to implement the type of financial model, but the return on assets and return on net assets improved significantly, which primarily due to the quicker cash flow and more free funds taken up. We also found that, after 2007, the real estate sector's cash flow and net commercial debt show a relatively upward trend and the difference in the rate of return on capital is no longer significant. Thus, the type of similar financial model is significantly influenced by the macroeconomic environment, especially in the deteriorating external environment. We believe that China's real estate industry must strengthen other aspects of management, such as pay more attention to enhance the brand value to pursue profit.

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Research on Financial Backing of Technological Innovation in Heilongjiang Province by System Dynamics

Xiu-ying Guo, Xiao-lei Yang, and Xiao-feng Hui

Abstract From the perspective of system dynamics, this paper carries out the study on the quantitative analysis of financial support to technological innovation in Heilongjiang Province and achieves the model by the software Vensim. Based on in-depth analysis and constituent elements data of technology innovation funds from 2000 to 2010, the network of enterprise's technological innovation is set up as a system dynamics model in three aspects: increasing public financial investment, assessing the development level of financial industry and reasoning the financial industry's participation to simulate and predict the trend. As the application of the model, the key indicators of innovation technology in the next few years are predicted for management decisions.

Keywords Financial backing • Innovation • System dynamics • Technology

1 Introduction

In modern economy, technology and finance has become the most active factor in the social productivity. Finance acts promoting, protecting and pulling function to science and technology (Stupples 2002). The combination of technology and

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finance is the objective necessity of economic development. Technological finance will become the new modern finance, the most likely to achieve the third wave of finance and to complete another financial metabolism. As we can see from history, the significant progress and application of technology are all based on financial innovation, showing that the finance has strong pulling power of technological innovation. In the stage of research, application and industrialization of any technological achievements, the financial market not only solve the problems of funds to fulfill the continuing enlarged capital demand but also provide the function such as risk aversion, corporate governance, incentive and constraint, value discovery, flow supply and so on.

At present, foreign research on technological finance is mainly reflected in the following two aspects: one is the financial role and choice of technological innovation, the other is the financial mechanism of technological innovation. Domestic study on technological finance is late and mainly includes the following categories: (1) the theory of technological finance (Roberts 1998; Cooper 1980); (2) the situations, problems and countermeasures of domestic technological finance system (Kaplan 1991; Zhao Fei and Hei Haiyam 2009; Tang Qing and Yuan Huiming 2011); (3) international comparisons of financial support for technological development (Zhao Fei and Hei Haiyam 2009; Tang Qing and Yuan Huiming 2011; Li Jin hua 2008; Wang and Xia 2008; Tojo); (4) The empirical research on financial impact of technological development (An Xiaohui et al. 2007; Zhong Shuhua and Wang Yankun 2007). All these studies have shown that: the financial support has become the important themes in the field of technology innovation.

The study on the combination of technology and finance is few and especially lack of empirical research in Heilongjiang Province. Therefore the research on financial involvement and support of technological development in Heilongjiang Province can not be systematic and deepen. In the process of technological development, a complex network system which is a nonlinear process contains a number of material and information feedback loops is established by the financial industry and technological enterprise. System Dynamics is a theory of computer simulation to deals with problems of multiple feedbacks in socio-economic. Based on in-depth analysis of the constituent elements of technology innovation funds, the network of enterprise's technological innovation is set up as a system dynamics model in the views of increasing public financial investment; the development level of financial industry; increasing the financial industry's participation in technological innovation to simulate and predict the trend.

2 Feasibility Analysis of the System Dynamics

System Dynamics (SD) was founded in 1956 by Professor Forrester of Massachusetts Institute of Technology and became an independent subject in the late 1950s. System Dynamics is named as industry dynamics for its primarily industrial using and introduced to China in the late 1970s, after two decades of research and application SD has achieved rapid development comparing with other modeling methods, SD has the following main characteristics, which can better meet the requirements of macro-strategic analysis and planning on the financial support for technological innovation (Zhao Liming and Zeng Xin 2012; Zhi and Gao 2011).

1. Suitable for the treatment of chronic and recurrent problems
   It is need a long historical stage to observe periodic law in financial technology innovation as well as the macro-strategic analysis and model is achieved by long-term vision and simulation.
2. Suitable for the problems of strong causality
   It is difficult to quantify various elements of the financial support of scientific and technological innovation system but the clear causality relationship between elements can be expressed and modeled.
3. Suitable for the complex socio-economic problems
   In general, it is very difficult to solve complex system described by the high order nonlinear equation by ordinary mathematical methods, SD can get the main information by means of computer and simulation techniques.
4. Emphasize the conditional forecast
   Most of Socio-economic systems are emphasis on the future, and the method of SD stresses the correspondence of the conditions with results under different test conditions by simulation. The comparison of the outputs under different strategies pre-settled in advance which can achieve the comprehensive analysis on macro-strategy of technological innovation.

For all these reasons, SD is an ideal tool for macro-strategic modeling and analysis on the financial support of technological innovation in view of its successful application in socio-economic and ecological environment.

3 System Dynamics Model of Technological Innovation

3.1 System Dynamics Model

The system dynamics model includes causality diagram and flow diagram. The former based on feedback loops bias in qualitative analysis and can express the enhanced or weakened relationship between the various elements. Positive and negative relationships in causality diagram were showed by the "+\–" arrow. After a closed -loop transfer, the variable finally is increased, such a circuit is called a positive feedback loop, otherwise the negative feedback loop (Wu Chuanrong et al. 2010; Miao Lina and Hu Guohui 2008).

For quantitative analysis, flow diagram is made up by flow variable, flow rate variable and information. Different from the causal diagram, the distinction between flow variables and flow rate variables in the flow diagram is established. Variable flow showed in the rectangular box is an accumulation changing with time and the storage link for matter, energy and information. Flow rate is under bow, such as increasing tax rate, capital investment rate. Auxiliary variables or constants is without rectangle such as finance income, capital investment. The cloud-shaped icon indicates the boundaries of the system. The feedback relations with its variables defined in mathematical formulas can be quantitatively expressed.

3.2 Model Construction

By analysis the system dynamics model of technology innovation financial support system in Heilongjiang province is established as Fig. 1.

3.3 The Compilation System of Equations

$GDP = INTEG(v_g - v_t,\ 1,731.7)$
$GI = INTEG(v_t, 213.9)$
(GI – Fiscal revenue)
$RI = [GI \times (1 + v_{gi}) + FI \times (1 + v_{fi})] \times v_{ri}$
(RI – Government Appropriation R&D Funds)
$EI = [GI \times (1 + v_{gi}) + FI \times (1 + v_{fi})] \times v_{ei}$
(EI – Education investment)
$TI = [GI \times (1 + v_{gi}) + FI \times (1 + v_{fi})] \times v_{ti}$
(TI – Technology input)
$FA = [GI \times (1 + v_{gi}) + FI \times (1 + v_{fi})] \times v_{fa}$
(FA – The added value of investment in fixed assets)
$SI = INTEG(v_{si}, 139.7)$
(SI – Securities and Insurance development level)
$B = INTEG(v_b,\ 2,285.5)$
(B – The bank development level)
$F = SI + B$
(F – The financial industry development level)
$FI = INTEG(v_{fi}, 12.52)$
(FI – Capital investment)
$TN = INTEG(v_{tn},\ 13,371)$
(TN – Number of Scientific research project)
$TP = INTEG(v_{tp},\ 33,976)$
(TP – Number of high-quality people)
$NN = INTEG(v_{nn},\ 70,522)$
(NN – Number of new technology)
$FN = INTEG(v_{fn},\ 1,275.9)$
(FN – Net value of fixed assets)
$TIR = TN/RI + TP/EI + NN/TI + FN/FA$
(TIR – Scientific and technological innovation rate)

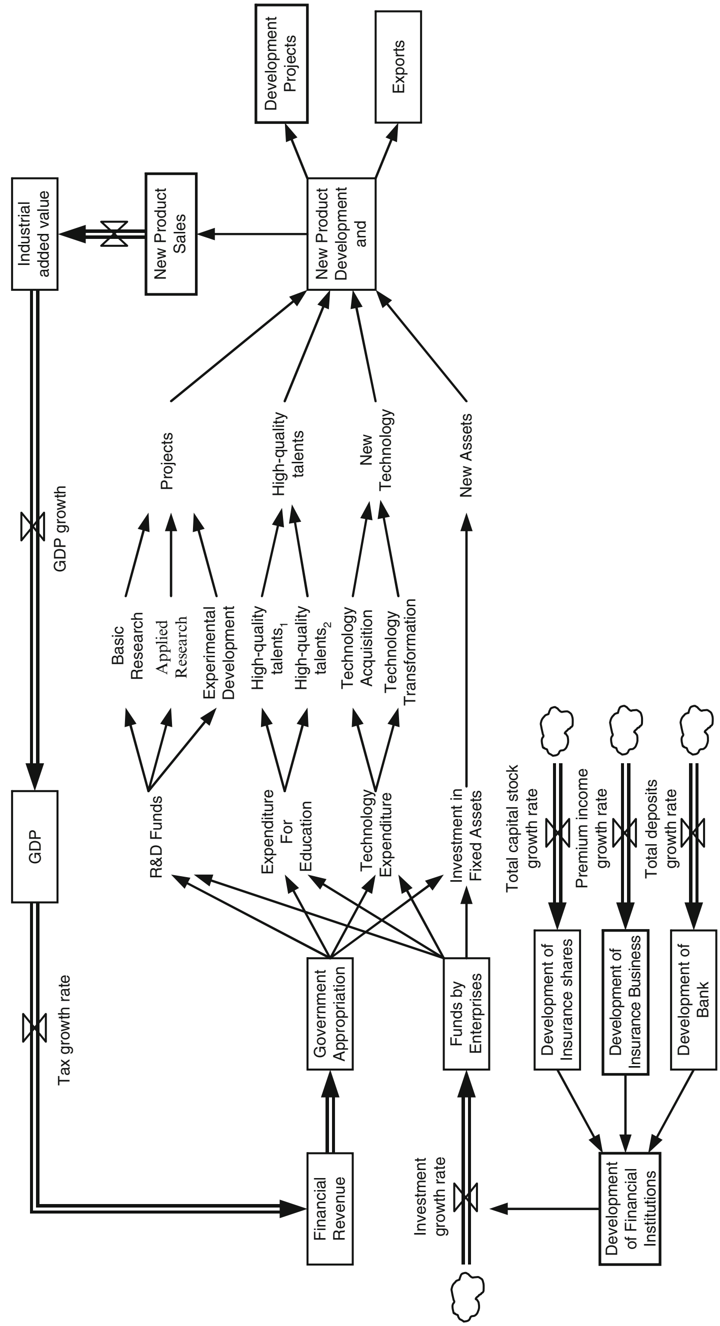

Fig. 1 Technology innovation financial support system dynamics model in Heilongjiang province

Among them, the weighted average of the 2000–2010 data, $v_t = 0.1043$, $v_{fa} = 0.297$, $v_{si} = 0.2143$, $v_b = 0.176$, $v_{tn} = 0.094$, $v_{tp} = 2.4533$, $v_{nn} = 0.155$, $v_{fn} = 0.128$.

4 Simulation and Analysis of Results

4.1 Data Sources

Heilongjiang Province financial support and policy simulation database is established by 2000–2010 Statistical Yearbook released by electronic data.

4.2 Simulation Tool Selection

This model is implemented by Vensim-a Windows -based interface, which provides a powerful graphical editing environment. In Vensim, some constraints can be preset to variables by common sense and basic principles.

4.3 Simulation Scenarios

Constrained by financial support, the impact of technology innovation by the variables of public finance investment, finance development and financial participation is studied and simulated by Vensim to maximize the technological innovation in Heilongjiang province. Base Value: 2010 data for the base value.

4.4 The Analysis and Application of Simulation Results

4.4.1 The Impact of Increasing Public Financial Input

As we can see from Fig. 2: If the current public finance input is changed from 0.4 (■ Current1) to 0.6 (▲Current2), the impact to technology innovation is not obvious and delayed. Due to the huge risk of a direct technological investment, government capitals can't provide large, sustained and long-term investment. For its long-cycle role, the government investment on education and research can fulfill personnel and technical requests of the technological innovations, but is relatively lagging behind. Coupled with the limitation of the government funds on technological innovation can not produce scope effect and reduce the effective transfer of technological innovation.

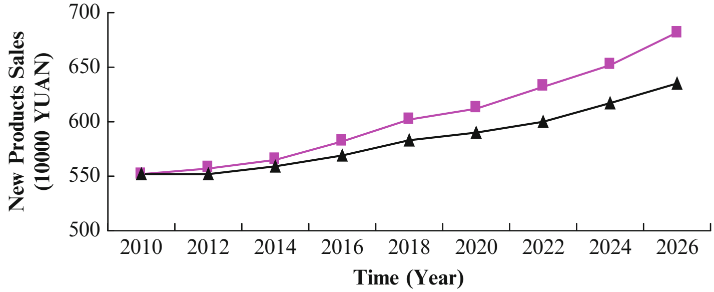

Fig. 2 The impact of increasing public financial input (color figure online)

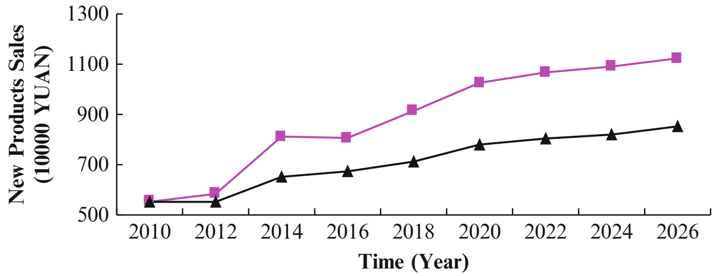

Fig. 3 The impact of financial development

4.4.2 The Impact of Financial Development

As we can see from Fig. 3: If it is lifted from 0.55(■Current1) 0.60 (▲Current2), the developing speed and scale of financial sector have a significant impact on technological innovation. The main reasons are: First, a favorable financial ecological environment can improve capital efficiency, reduce transaction costs and the risk of technological innovation. What we say here “financial ecological environment” mainly refers to the interactive and interdependent relationships of economic and financial in the socio-economic co-ordinate development. By the establishment of benign regulating, developing and running financial environment, the scientific flow of information and fund between economic and financial interactions is implemented. The coordinated, balanced, sustained, efficient development of economy and finance is promoted. Second, technology innovation needs a lot of money, the essence of financial operation is to setup bridges between savers and investors, to provide channels from surplus departments to short departments. The development of financial industry, not only can enhance the liquidity and efficiency of capital, strengthen the confidence and motivation of innovation but also play a vital role in the adjustment of industrial structure. Third, the popularity of cross-border and long-term settlement can convenience the exchange and avoid the risk of rate. The billing channels can fast and convenience technology innovation by the high level

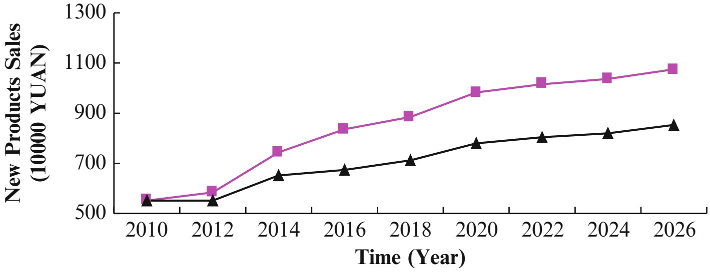

Fig. 4 The impact of increasing financial industry's participation

financial services and diversity of means of payment, thereby greatly improving the efficiency of funds. Fourth, with the development of financial intermediary which can absorb social savings and loan to borrowers, the conversion from saving to investment channels is achieved. The more financial intermediation developed the more smooth investment channel is. For the financial sector is the concentrating center of social capital, contacting with thousands of families and businesses, their sources and ranges of information are very large, in addition to funds flow and credit status, the perfecting financial intermediary services can also provide market trends, industry policy, commodity information and so on. Based on the above reasons, the development of the financial industry is prerequisite of the industrial revolution, which can not only provide substantial, sustained, long-term investment in any stage of technological study, application conversion and the industrial transformation, but also greatly increase the valid transfer of technological innovation.

4.5 The Impact of Increasing Financial Industry's Participation

If the effective link between finance and technological innovation is lifted from 0.4 (■Current1) to 0.6 (▲Current4) in Fig. 4. We can see that the higher of the link the remarkable achievement of technological innovation. The main reasons are: the innovation of financial products and services can broaden enterprises' financing channels. The traditional mortgage can not meet the development needs of many high-tech and innovative enterprises which are mostly in its infancy, small scale and repayment ability is weak, lack of land, real estate and other collateral. A kind of risk funds can be established on the mortgage of technological contracts, by the injection of banks and government to compensate for the loss of technological project. In this process a financial group familiar with the technological work and a technology management team understanding finance are developed. By the enhancing of professional level, financial planner can design different financial products according to the characteristics of different industries to reduce the risks of funding breaks in technological innovation. Further integration of finance and technology is formatted by the sharing of risks through banks, enterprises and the government. Only by increasing the participation in technological innovation, a more fully functional protection of risk aversion, corporate governance, incentive and constraint, value discovery, liquidity supply and so on can be provided by financial market.

5 Ending

The construction of financial service system for technological innovation has become an urgent subject in Heilongjiang province. By using the method of system dynamics to build a model of financial input for technological innovation which gives a visual description internal interpretation on the effect of government input, financial development and integration of finance and technology. But this article still has some limitations in model construction, data selection, in the next study we will further optimize the model and improve the data source.

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Long-Run Performance of IPOs: Phenomenon and Theories

Jia-wei Zhang and Yi-fang Liu

Abstract The long-run underperformance of IPOs is one of the three anomalies in IPOs. Many scholars have carried on various researches on it since Ritter firstly found the long-run underperformance of IPOs. This paper investigates in the empirical and theoretical studies on the long-run performance of IPOs since Ritter. It gives a full introduction of the changes of methods for measuring the long-run performance of IPOs, controversies of empirical results, comparisons of the influencing factors, and theoretical explanations from different perspectives. At the end, some points of future research are presented.

Keywords Influencing factors • IPO • Long-run performance • Measuring methods • Theoretical explanations

1 Introduction

Research on the long-run performance of initial public offerings has been a hot issue since Ritter documented his findings in the early 1990s (Ritter 1991). Considering several different measures and benchmarks, Ritter evaluate the 3-year aftermarket performance of 1,526 initial public offerings in 1975–1984, and find that these firms significantly underperformed the market and a set of comparable firms matched by size and industry. After that, further research has been done and suggests a 3–5-year long-run underperformance in American as well as other markets. Such is the long-run underperformance hypothesis, which means in generally 3–5 years after their going public firms significantly underperform benchmarks such as market indices and comparable firms with the performance measured by the long-run holding

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period return from the closing market price on the first day of public trading. The long-run underperformance anomaly challenges the Efficient Market Hypothesis, and constitutes the three main issues with another two anomalies, the first-day under pricing and the "hot issue" market.

This paper focuses on research on the long-run performance of IPOs after Ritter's, especially after 2000. The structure of this paper is as follows. Section 2 contains three parts. Firstly it introduces the methods for measurement of the long-run performance of IPOs; secondly, it tells what empirical studies find about the long-run performance based on the methods; thirdly, some influence factors such as reputation of underwriters and venture capital are presented. Section 3 describes some explanatory theories on the long-run underperformance of IPOs. Conclusions and some points of further research are pointed out in the last section.

2 Empirical Studies

2.1 Methodologies

To evaluate the long-run performance of IPOs is to get the abnormal return during a period. Two values are needed here, the initial return and the expected return of a stock during a specific time horizon. Thus two issues need to be considered. One is the choice of benchmarks, and the other is measurement of return.

For the first one, it is used to determine the expected return. Several methods are available here according to Jason Draho (Draho and Jianbao 2006). A simple one is using portfolios or market indices, but the shortcoming comes to be that it ignores issuers' specific risk characteristics. Another method is to compare issuers with comparable firms which have been public long ago, so that the risk factors and cash flow characteristics of the expected return are taken into consideration. Also, asset pricing models are also available here to evaluate the expected return. CAPM shall confirm the factors that affect the expected return and price them, thus it will be easy to perform statistical tests on abnormal returns. CAPM, the Fama-French three-factor model and the arbitrage-free pricing model are frequently used.

For the second issue, two measures are used to calculate abnormal return: (1) buy-and-hold abnormal returns (BHAR) calculated with the difference of the buy-and-hold returns of IPO firms and that of comparable firms, and (2) cumulative abnormal returns (CAR) calculated with sum of the differences of monthly returns of IPO firms and that of comparable firms. However, the two measures only apply to market-reference method and control-firms method.

Besides the two issues, the differences between equally weighted and value-weighted returns need to be considered as well. Loughran and Ritter point out that average of the wealth relatives arise to 0.8 from 0.7 when the value-weighted way replaces the equally weighted (Loughran and Ritter 1995). Brav, Gezcy and Gompers suggest that the choice of methods depends on the explanatory power of certain statistics and whether investors are interested in these statistics (Brav et al. 2000). If the target is wealth changes of IPO investors, the value-weighted way shall be closed. And if the target is to test the impact of potential mispricing on IPOs, the equally weighted way is better.

By far, there isn't a generally applicable method for research on the long-run performance on IPOs, and the results with these different methods are divergent. These statistics methods can be classified from different views: event-time method and calendar-time method from time measurement, market risk adjusted method and control company risk adjusted method from selection of benchmark, cumulative abnormal returns and buy-and-hold abnormal returns from evaluation of returns, value-weighted method and equally weighted method from combination weights of IPO firms. There are several subtile differences between these classifications and those of Jason Draho, mainly on the time measurement. Generally, CAR and BHAR are considered as event-time method for they inspect on the performance of a period after IPO, while CAPM and Fama-French three-factor model are considered as calendar-time method to solve the problem that event-time returns of each stock in a portfolio are not independent because of the correlation of event-time returns of different stocks.

To distinguish between event-time method and calendar-time method is commonly used in research on IPOs. For example, Gompers and Lerner compare these two methods with the long-run performance of IPOs before NASDAQ market arises (Gompers and Lerner 2003). The second part of this section describes empirical studies on the long-run performance of IPOs and how the methods affect the results.

2.2 Empirical Results

Ritter puts forward three unsolved issues in his paper of 1991, respectively years the long-run underperformance lasts, universality of the results and the relationship between the long-run underperformance and the short-run under pricing. Based on that, Loughran and Ritter go further with IPOs and SEOs in 1970–1990 and show that both IPOs and SEOs suffer a 5-year underperformance (Loughran and Ritter 1995). Though it seems that the long-run underperformance dominates, alternative findings exist as scholars do the work from different views and using different kinds of statistical methods.

To expand the time span and explore more kinds of markets, Gompers, P.A. and J. Lerner extend the time line through 1935–1972 before NASDAQ arises, and find that there does existence long-run underperformance under calendar-time method and BHAR used while the anomaly disappears under CAR (Gompers and Lerner 2003). What's more, the holding period return of IPOs is equal to that of the market when calendar-time method is used as the hypothesis that the intercept of the CAPM model and the Fama-French model is zero is statistically insignificant. Schaub, M. and M. J. Highfield concentrate on American Depository Receipts issued or seasoned in 1987–2000 (Schaub and Highfield 2004). What is interesting is that they find that the buy-and-hold return of ADR IPOs and SEOs which are issued before June 1, 1998 is lower than that of S&P 500 index in short-run and long-run, while ADRs after the point perform better than or at least the same as the market indices. Thus they suggest that the long-run performance of IPOs is related to issuing time. Buttimer, R. J., D. C. Hyland, et al. put their eyes on Real Estate Investment Trusts as they think that REITs are more transparent than other financial products (Buttimer et al. 2005). No sign of long-run underperformance are presented however.

More research focuses on performance of IPOs in different markets around the global. Yan, D. and J. Cai study 700 IPOs in Japanese OTC market from 1991 to 2001 and present evidence which suggests that IPO firms significantly and persistently underperform whether from the view of industry adjustment or mean reversion adjustment (Yan and Cai 2003). Cheng, S. R. and C. Y. Shiu test the anomaly in Taiwan using monthly adjusted BHAR and CAR and present 3-year negative abnormal return after IPO (Cheng and Shiu 2005). In addition, they test that using single factor model and three-factor model under calendar-time method and show a 19 % loss in IPOs compared to the benchmark. In Malaysia, however, Ahmad-Zaluki, N. A., K. Campbell, et al. analyze the 454 IPOs during 1990 and 2000, and find that the long-run outperformance of IPOs with CAR and BHAR compared two market indices under event-time method, which is different from the developed country (Ahmad-Zaluki et al. 2007). But when Fama-French three-factor model under the calendar-time method is used, the significant abnormal returns disappear. Kooli, M. and J. M. Suret do the same job in Canada with 445 IPOs in 1991–1998 and also show a 5-year long-run underperformance (Kooli and Suret 2007). Sapusek A. investigate the IPOs in German during 1983 and 1993, and suggests that with different benchmarks, indices or control companies, the result could be long-run normal performance, long-run underperformance or long-run outperformance using BHAR (Sapusek 2000). Gregory, A., C. Guermat, and F. Al-Shawawreh expand the time span from 1975 to 2004 within London (Gregory et al. 2010). With the 2,499 IPOs, they present the result of long-run underperformance which depends on certain method of measuring abnormal returns.

Findings in Chinese markets cannot reach to a consensus. Chen, G., M. Firth, and J.B. Kim show that in 3 years after initial public offerings, B-listed firms underperform A-listed firms (Chen et al. 2010). They get to this with 277 A-listed IPOs and 65 B-listed IPOs in 1992–1995. Instead, Chan, K., J. Wang, and K.C.J. Wei investigate IPOs in A shares and B shares during 1993–1998 and suggest that the long-run performance of A-listed IPOs is a bit poor than portfolios of comparable sizes and book-to-market ratios, while that of B-listed IPOs is better (Chan et al. 2004). Chi, J. and C. Padgett's empirical studies present a 3-year long-run outperformance of about 10 %with IPOs in 1995–1996 as sample (Chi and Padgett 2003). With 744 A-share IPOs during 1995 and 2000, Lin Mao and Yang Dan compare the calendar time with the event time, and suggest that 3-year performance of IPOs in China is better than market indices or control stock portfolios (Mao and Dan 2006). For the CAPM model and the Fama-French three-factor model, both of them have positive abnormal returns, while the three-factor model has more explanatory power.

We shall conclude that the results are quite sensitive to the statistical methods selected though most of the studies prove the long-run underperformance hypothesis. Thus some scholars concentrate on improving the methods. Considering that the CAR based on event-time method does not follow normal distribution, Ho, K. Y. compare the nonparametric random dominating tests of distribution of IPO firms and benchmark index (Ho 2003). Using the same data of Ritter in 1991, he suggests that IPOs do not underperform benchmark index in long run. Abhyankar, A., H.C. Chen, and K.Y. Ho try to apply non-event methods, and prove that there does not existence first order advantages for IPOs against market index while there exist for market index against IPOs when it comes to the second order (Abhyankar et al. 2006). Thus it indicates that what's important here is to define certain methods and make clear the distribution of benchmarks when evaluating the performance of IPOs and benchmarks.

2.3 Influencing Factors

Factors affecting the long-run performance of IPOs follow. These involve enterprise quality, issue size, underwriter's reputation, extent of earnings management, participation of venture capital, changes of corporate management.

From the perspective of enterprise management, many scholars explore the influence earnings management before IPO and its operations after issuing on the long-run performance. Roosenboom, P., T. van der Goot, and G. Mertens discuss the earnings management and show that the accrued size in the first year after IPO is negatively related to the 3-year price performance (Roosenboom et al. 2003). Chang, S. C., T. Y. Chung, and W.C. Lin study the underwriter's reputation and earnings management and present evidence which suggests that underwriters who have good reputation will carry out strict supervision and are able to limit the extent of earnings control (Chang et al. 2010). Thus the negative correlation between earnings management and the long-run performance of IPOs emerges when the reputation of underwriters is not particularly high. Chemmanur, T. J. and I. Paeglis focus on the influence enterprise quality and reputation have on the long-run performance of IPOs (Chemmanur and Paeglis 2006). They deem that firms will perform well in long run if they are subject to management with high quality as differences of the expectations of investors will be smaller. What's more, good managers tend to choose better projects and carry out them efficiently, thus good management quality leads to better long-run performance of IPOs. They empirically prove these hypotheses. Li, L. and T. Naughton show that the long-run performance is better if the obligations of CEO and the board are departed when they discuss the relationship between the performance and management changes (Li and Naughton 2007).

As firms' going public is one of the most important ways venture capital exits, much research resides here. Comparing the influences of the reputation of investment bank and venture capital, Doukas, J. A. and H. Gonenc suggest that the IPOs are better off when venture capital participates and reputation of investment bank will have effect only when no venture capital in Doukas and Gonenc (2005). Campbell II, T. L. and M. B. Frye find that the proportion of directors and supervisors presents positive correlation with long-run performance and that firms with venture capital shall have lower risk of asymmetry by attracting analysts and big shareholders, and thus achieve long-run outperformance (Campbell and Frye 2006). Krishnan, C. N. V., V. I. Ivanov, et al. come to the same conclusion that participation of venture capital heralds better long-run performance (Krishnan et al. 2011).

Research on these impacting factors gives support to different interpretation theories from different perspectives, and put forward some suggestions and ideas to improve these anomalies at the same time.

3 Theories of Long-Run Underperformance of IPOs

To explain the long-run underperformance of IPOs, theories are proposed and divided into theories from the view of behavior finance, theories from the view of information asymmetric, and from the view of efficient market hypothesis.

Scholars that stand by the behavior finance insist that it is the investors' irrationality that leads to the long-run underperformance. There are three systematic explanations here. The first is the opinion divergence hypothesis, which is proposed by Miller in 1997. With the volatilities of returns before IPOs as the proxy variable of extent of opinion divergence, Gao, Y., C. X. Mao, and R. Zhong present that the extent of opinion divergence is negatively related to the long-run performance of IPOs, and when opinions on the stock value convergence as time goes on, the price is going downward (Gao et al. 2006). The second is the host hypothesis, which means that the investment bank will try to advertise and package the firms at the point of going public in order to motivate investors to buy and as there is no need to promote the firm after its going public, the price will fall naturally. The third is the "opportunity window" hypothesis which stands for that issuers always have the right to decide the time of going public, and mostly they are going to issue when they are optimistic about the industry or when they are at the peak of earnings. Expansion waves of firm's going public and explicitly decreasing of market expectations after IPOs suggest that there exist systematically optimistic estimation in the market and "opportunity window" for going public. Wu, C. and C. C. Y. Kwok compare firms that go public in domestic markets with firms that go public globally and find that the global firms perform not as well (Wu and Kwok 2007). These prove the "opportunity window" hypothesis as investors are always overly more optimistic on global offering firms, and once the high expectations were corrected, poor performance will occur.

Information researchers focus on the asymmetric information in IPOs. Investors are at information disadvantage compared to issuers, and thus issuers shall make use of information advantages in order to be self-improvement. Several reasons here are used to explain the long-run performance of IPOs. The first is earnings management. Both Roosenboom, P., T. van der Goot, and G. Mertens and Chang, S. C.,

T. Y. Chung, and W.C. Linsuggest that earnings management before IPOs will not go for long as the price will fall once investors perceived the feint (Roosenboom et al. 2003; Chang et al. 2010). The second is earnings forecasts which are overly optimistic, mostly because of analysts' optimistic forecasts. Jain, B. A. and O. Kini present that hot issues happen in industry who owns high growth opportunity (Jain and Kini 2006). They also point out that when firms go public at the point where most of the firms in the industry go, their long-run performance will be poor. It proves that when many firms in one industry chase the same investment opportunity, there will be overly optimistic estimation about these firms. While after a period of time, investors are going to wake up, and the prices fall. The third is the signaling hypothesis which means issuers can choose underwriters with good reputation and prove the quality of the firms. Thus IPOs with participation of good underwriters and venture capital perform better in long run, as Doukas, J. A. and H. Gonenc (2005) and Krishnan, C. N. V., V. I. Ivanov, et al. suggest (2011).

Based on the efficient market hypotheses, Fama proposes the theory of bad model. He finds that it has the same probability for the new shares to have long-run underperformance or outperformance, and it does not contradict with the theory that the return follows random walk (Fama 1998). Thus it is the bad model that leads to the long-run underperformance. With empirical studies, Gompers and Lerner prove that the effect of choosing appropriate model should not be ignored (Gompers and Lerner 2003). Some other scholars carry out many studies on methods chosen and get valuable results.

Besides the classification according to theory school, many scholars try to explain the long-run performance of IPOs from the perspective of behavior of market participants, which include investors, underwriters or the issuing firms. Theories from the perspective of behavior of investors include the opinion divergence hypothesis, fever investors hypothesis and the window of opportunity hypothesis. From the view of underwriter, the theories include price support hypothesis and from the issuing firms, there exists overly packaging and timing issuing.

We think that the two ways to classify the theories are complementary. However, these explanations are not consistent with each other and not absolutely correct. For example, Kooli M and J.M. Suret suggest that the opinion divergence hypothesis can't explain the underperformance of Canadian market while "hot issue" and fever investors hypothesis can well explain it (Kooli and Suret 2004). This shows that these interpretation theories need further research.

4 Conclusion

As one of the three anomalies of IPOs, the long-run underperformance has earned enough attention especially since Ritter presented his founding. The paper fully discusses changes of the methods for measuring the long-run performance of IPOs and the importance of the method chosen. Because of the differences of the methods chosen and differences of markets, there exist controversies of empirical results. And yet for all, empirical studies present some influencing factors, based on which several theoretical explanations from different perspectives are proposed. We conclude all these and think that, further research should focus on the modification of methods measuring the long-run performance, and thus effectively prove those theories on long-run underperformance of IPOs.

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Part III
Engineering Management – Construction Management

Analysis to Elements Influencing the Scale of Investment and Construction of Security Housing in Shenyang

Ya-chen Liu and Shuai Dong

Abstract Through the model of grey correlation analysis, this article analyzes the elements influencing the scale of investment and construction of security housing in Shenyang and gives the calculation process of the analysis to grey correlation, and connecting the cases in Shenyang, selects the relative indicator's data of security housing from 2005 to 2010, and through calculating corresponding data, gets degree of association influencing relative indicator of scale of investment and construction of security housing which is sequenced and analyzed about the result before gets some conclusions concerning the elements influencing the scale of investment and construction of security housing in Shenyang.

Keywords Degree of association • Grey correlation analysis • Security housing • Shenyang

1 Introduction

As our urbanization speeds up, the housing price also increases quickly and middle and low income families are difficult to resolve the living problem through the market. To guarantee that the middle and low income families have the places to live in, our government will put the policy of guarantee housing into effect (Holt et al. 2007; Alvesson and Karreman 2011; Xu Feng et al. 2007). Guarantee housing is one kind of policy-related house which is used to guarantee the middle and low income families by the government and the carrying out of guarantee housing remits the problem of living housing of middle and low income families greatly (Qi Hua 2009; Hu Zhiyuan and Ou Xiangjun 2007).

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It will be the key function to realize that our guarantee housing develops rapidly and greatly to analyze the investment and construction scale of guarantee housing, and realizing continuous development of guarantee housing must coordinate with development level of the city. There are many elements influencing the investment and construction scale of guarantee housing. This article makes specific analysis connecting the case of guarantee housing in Shenyang and selects some indicators such as urbanization rate, GDP, the average proceeds of resident, the price of commodity houses, Engel coefficient and analyzes Shenyang city through using grey correlation analysis (Hu Zhiyuan and Ou Xiangjun 2007; Wen Linfeng 2009).

Grey Correlation Analysis is invented by professor Deng Julong in 1980s and the methods has a lot of advantages such as that the data volume which is suitable for evaluating indicator is not big and the data does not have distribution statistic law and the relative bigger mistake will not emerges in the calculation result because of the influence of error, etc. It can evaluate out the elements influencing the investment construction of guarantee housing and analyze out the tightness degree between the elements and guarantee housing to apply Grey Correlation Analysis to guarantee housing which provides the suggestion for the development of our investment construction of guarantee housing and the real realization of healthy continuous development of guarantee housing.

2 Calculation of Grey Correlation Analysis

2.1 Grey Correlation Analysis

Grey Correlation Analysis is one kind of methods evaluating the tightness degree among the indicators in the system. In the calculating process, the data needs dimensionless and then through using the analysis of correlation degree size, the size of sensitiveness degree of elements can be compared.

1. Calculating the coefficient of association

$$L_{0i} = \frac{\min\limits_{i}\min\limits_{k}\left|x_0^{(1)}(k) - x_i^{(1)}(k)\right| + \zeta\max\limits_{i}\max\limits_{k}\left|x_0^{(1)}(k) - x_i^{(1)}(k)\right|}{\left|x_0^{(1)}(k) - x_i^{(1)}(k)\right| + \zeta\max\limits_{i}\max\limits_{k}\left|x_0^{(1)}(k) - x_i^{(1)}(k)\right|} \quad (1)$$

$L_{0i}(k)$: coefficient of association on dot “k” between x_i and x_0, ζ: resolution ratio, select the data in [0,1], usually it is 0.5.

minimum differential between two poles:

$$\min\limits_{i}\min\limits_{k}\left|x_0^{(1)}(k) - x_i^{(1)}(k)\right| \quad (2)$$

maximum differential between two poles:

$$\max_i \max_k \left| x_0^{(1)}(k) - x_i^{(1)}(k) \right| \tag{3}$$

2. Calculating correlation degree of grey

$$r_{0i} = \frac{1}{m}\sum_{k=1}^{m} L_{0i}(k) \tag{4}$$

r_{0i} represents for correlation degree between comparing sequence x_i and reference sequence x_0

3 Case Analysis

Analysis to elements influencing the scale of investment and construction of security housing in Shenyang. There are a lot of elements influencing guarantee. This article correspondingly selects five kinds of elements influencing investment construction of guarantee housing. Through the survey to statistical yearbook of Shenyang, the data from 2005 to 2010 is selected among which only the data about economically affordable housing is issued and here the investment capital of economically affordable housing is use as the investment capital of guarantee housing. The specific data is based on the Table 1 (Wen Linfeng 2009; Shang yumei 2007; Buchanan et al. 2005).

3.1 Constructing the Reference Sequence and Comparing Sequence

The investment capital of guarantee housing is used as x_0, the rest element is used as the comparing sequence and the indicators above are written as matrix form.

Table 1 The original data table of elements influencing the investment construction scale of guarantee housing

Indicator	2005	2006	2007	2008	2009	2010
Amount of capital invested x_0 (one hundred million yuan)	17.4	31.2	27.4	24.1	26.4	27.8
Urbanization rate x_1 (%)	71	71.1	71.1	71.3	71.5	71.6
GDP x_2 (one hundred million yuan)	2,084	2,520	3,221	3,860	4,269	5,017
Average proceeds of resident x_3 (yuan)	28,089	35,940	45,582	48,230	53,794	62,357
Engel coefficient x_4 (%)	38.8	37.2	35.3	38.2	35.7	31.7
Price of commodity house x_5 (yuan)	3,187	3,376	3,689	4,127	4,464	5,411

Table 2 Disposing result of equalization

Number	Indicator	2005	2006	2007	2008	2009	2010
1	x_1	0.6766	1.2132	1.0655	0.9371	1.0266	1.0810
2	x_2	0.9963	0.9977	0.9977	1.0005	1.0033	1.0047
3	x_3	0.5963	0.7210	0.9216	1.1044	1.2214	1.4354
4	x_4	0.6151	0.7870	0.9982	1.0562	1.1780	1.3655
5	x_5	1.0733	1.0290	0.9765	1.0567	0.9876	0.8769
6	x_6	0.7884	0.8352	0.9126	1.0209	1.1043	1.3386

Table 3 The sequence differential between reference sequence and all kinds of comparing sequence

Number	Indicator	2005	2006	2007	2008	2009	2010
1	Δ1	0.3197	0.2156	0.0678	0.0633	0.0233	0.0763
2	Δ2	0.0804	0.4922	0.1439	0.1672	0.1948	0.3544
3	Δ3	0.0615	0.4262	0.0673	0.1190	0.1514	0.2845
4	Δ4	0.3967	0.1842	0.0890	0.1196	0.0390	0.2041
5	Δ5	0.1118	0.3781	0.1529	0.0838	0.0777	0.2576

$$X = \begin{pmatrix} 17.4 & 31.2 & 27.4 & 24.1 & 26.4 & 27.8 \\ 71.0 & 71.1 & 71.1 & 71.3 & 71.5 & 71.6 \\ 2{,}804 & 2{,}520 & 3{,}221 & 3{,}860 & 4{,}269 & 5{,}017 \\ 28{,}089 & 35{,}940 & 45{,}582 & 48{,}230 & 53{,}794 & 62{,}357 \\ 38.8 & 37.2 & 35.3 & 38.2 & 35.7 & 31.7 \\ 3{,}187 & 3{,}376 & 3{,}689 & 4{,}127 & 4{,}464 & 5{,}411 \end{pmatrix}$$

Dispose the matrix form to equalization and the disposing result is as the Table 2.

3.2 Calculating the Correlation of Association

Differential sequence

According to $\Delta_i(k) = |x_0'(k) - x_i'(k)|$, the calculating result is as Table 3

According to the formula (2) and the formula (3), the specific data of sequence differential is as Table 3, the differential between the two poles is $\min_i \min_k \Delta_i(k) = 0.0002$, $\max_i \max_k \Delta_i(k) = 0.1839$

3.3 Calculating the Correlation of Association

According to the formula (1), the calculating result of grey correlation coefficient is as the Table 4:

Table 4 The table of correlation of association between reference sequence and comparing sequence

Number	Indicator	2005	2006	2007	2008	2009	2010
1	x_1	0.4762	0.5835	0.8582	0.8706	1.0000	0.8355
2	x_2	0.8252	0.3649	0.6908	0.6518	0.6110	0.4486
3	x_3	0.8758	0.4007	0.8597	0.7378	0.6777	0.5077
4	x_4	0.4191	0.6261	0.8040	0.7367	0.9449	0.5984
5	x_5	0.7527	0.4316	0.6752	0.8166	0.8319	0.5349

Table 5 Grey correlation degrees

Indicator	Urbanization rate x_1 (%)	GDP x_2 (hundred million)	Average proceeds of resident x_3 (yuan)	Engel coefficient x_4 (%)	Price of commodity house x_5 (yuan)
Degree of association	0.7707	0.5987	0.6766	0.6882	0.6738
Sequence	1	5	3	2	4

3.4 Calculating the Correlation Degree

According to the formula (4), the specific is as the Table 5

From the Table above, it can be known that the sequence of correlation degree is: $r_{01} > r_{04} > r_{03} > r_{05} > r_{02}$, that is to say that the sensitiveness degree of the elements influencing the investment construction scale of guarantee housing successively is: urbanization ratio, Engel coefficient, the average proceeds of resident, the price of commodity house, GDP.

4 Result Analysis

1. The factors affecting investment in low-cost housing construction scale is greater than 0.5, we can see that these indexes are the main factors influencing the construction of low-cost housing investment. But the GDP in Shenyang was not significant, which suggested that Shenyang economic development in good condition in these years, regional GDP in Shenyang and it is not as critical factors affecting low-cost housing construction scale in Shenyang.
2. Urbanization rate on low-cost housing construction investment is rather sensitive, the value of association degree is 0.8287, this is because urbanization rate in Shenyang is higher in nationwide and ranked No.1 in Liaoning province. More and more rural population turn into urban population and the income of this population is much lower, and their house is difficult to solve which need more low cost housing construction. Governments should pay attention to the housing

requirements of these groups to invest some funds as much as possible to meet the housing needs of these groups in the availability of the finance (Dibella 2007; Ford and Ford 1995; By 2005).

3. Per capita income and the price of commercial housing, Engel's coefficient showed significant consistent relationships, which all are above 0.67, they effected the scale of investment in low cost housing construction, this is because per capita income level becomes more big, then the price of commercial housing becomes higher. In 2011, the ratio of house price in Shenyang is 9.48 which is higher than the average international level. This indicates that the increase in house price surpasses the rise in per capita resident income (Buchanan et al. 2005). At this time, market housing cannot meet strongly housing requirements (Sturdy and Grey 2003). The demand of low cost housing is big requires corresponding government invest more funds in construction of low cost housing.

5 Conclusion

To achieve sustainable development in low cost housing construction, we need to analyze the factors affecting investment in low cost housing construction and to chase for the housing business which the government should focus on it to achieve organic coordination between social housing and urban development in China. This article analyzes the housing investment construction scale by grey associated analysis method, selecting the data of 2005–2010. We can conclude that the GDP in Shenyang city development situation has the lowest influence on the investment in low cost housing construction, which indicates the Shenyang economy develops in a good state not becoming the factor effecting low cost housing investment. Urbanization rate in Shenyang has significant influence on low cost housing investment. As for Shenyang Government, in the process of improving urbanization rate, it should pay close attention to the housing problems of low-income families, increase the investment in the low cost housing at the same time not to ignore the effects of commercial housing price and per capita income. The conclusions of this article provide a reference to safeguard the housing security in Shenyang city.

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Research on Construction Management Based on the WSR System Methodology

Wei-na Ji and Jun-jie Wang

Abstract This article applies Wuli-Shili-Renli system methodology to project construction management. It discusses principles of construction management based on the WSR; puts forward suggestions about the optimization of construction management from three aspects respectively: Wu-li, Shi-li, Ren-li. The aim is to realize the scientific and systematic management for construction process.

Keywords Construction • Management • Project • WSR methodology

1 Introduction

WSR system methodology is the abbreviation of Wuli-Shili-Renli system methodology. It was proposed by Chinese scholar Gu Jifa together with the Professor Zhu Zhichang at British Hull University in 1994, and had achieved international recognition. WSR is blessed with flavors of Oriental cultural and has become a powerful tool to solve complex problems (Gu and Gao 1998). Table 1 describes the basic contents of WSR system methodology (Gu et al. 2007).

Construction management is a whole process of management for construction project in planning, organization, arrangement, command, management, supervision, control and coordination with systematic viewpoints and theories as well as modern means of science and technology (China Association of Construction Education 2007). Thus it can be seen that the construction management process is an open and complex system. Based on the WSR system methodology, managers and constructors can better analyze the whole construction process scientifically and logically, and surely can promote the project construction more successfully.

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Table 1 The basic contents of WSR system methodology (Gu et al. 2007)

Element	Wu-li	Shi-li	Ren-li
Theory	The theory of the physical world, the rules and the planning	The theory of management and work	The theory of people, discipline and norm
Objects	Objective material world	Organization, system	People, group, intelligence interpersonal relationship
Focal point	What? Function analysis	How? Logical analysis	How best? Humanistic analysis
Principles	Honest, truth, as correct as possible	Coordinated, efficient, as smooth as possible	Humanistic, effective, as flexible as possible
knowledge	Natural science	Management science, systems science, operations research	The humanities, behavioral science

2 Principles of the Construction Management Based on the WSR System Methodology

When using the WSR system methodology, Gu Jifa etc put forward to the following principles should be paid attention: (1) the comprehensive principle; (2) the involved principle; (3) the operating principle; (4) the iterative principle; (5) the overall optimization principle (Gu et al. 2007). Based on this, when the WSR methodology is applied to the practice of construction management, the following principles should be emphasized.

2.1 The Comprehensive Principle

Construction management is a complex process that is composed of multiple parts. Its working spans diverse organizational boundaries and requires the knowledge of many subjects (Xue et al. 2012). Therefore, in order to get the best managerial effect, the process of organization management and technology management need to integrate different professional knowledge, set a variety of schemes and make up for each other.

2.2 The Involved Principle

In the whole process of construction, in addition to the construction personnel and supervisors, the project owners, designers, suppliers and the leading personnel of construction must be involved. Through the timely communication, all parties establish good relations, so as to make the construction personnel understand intentions of the project and learn from experience and correct the wrong idea.

2.3 The Operating Principle

The goal of construction management is to ensure the progress of the project goes on wheels. So the selection methods should be closely combined with project practice and cannot blindly pursue optimization while ignoring operability. The project's final results serve for the owners. It is essential to fully consider the practicality and the related interests when multi-disciplinary achievement and professional technologies are integrated.

2.4 The Iterative Principle

Don not attempt to make Iterative and learning in one step, but to consider new information constantly (Tan et al. 2010). During the construction, all the application process that contains three controls (cost, schedule and quality), three management (safety, information and contract) as well as organization and coordination should be iterative and cyclical. Continuous learning and feedback drive the project construction to success.

2.5 The Overall Optimization Principle

The project is a system in itself, and it also a subsystem of the social economic system. In the process of construction management, using the method of system science to manage and optimize the project comprehensively demands an especially focus on the coordination between the project and the system of environment, resources, culture, regional development planning.

3 The WSR Analysis in the Process of Construction Management

Analyzing the construction management from the angle of WSR, the Wu-li part contains following elements: construction drawings, construction organization design, construction drawing budget, construction contracts, construction materials, the environmental conditions (production and living base construction, hydropower, roads etc). These elements solve the problems of "what is project construction and what can be done about it" (Huang 2005). Then how to arrange and use these elements is the range of Shi-li. According to the science, Shi-li contains quantitative and qualitative parts (Miao 2010). All issues mentioned in this article are quantitative parts. The contents of Shi-li mainly refer to the construction methods and technology that answer the question of "How to do construction". The scope of Ren-li covers following problems: how should the construction side coordinate the interest relationship with the owners, design, supervision, supplier and construction project general contracting parties; the ability of construction side to deal with the crisis; the team culture and values etc. Ren-li uses the knowledge of human science and behavior science (Tan et al. 2010), which guide construction side "how to operate the construction best".

The following part discusses how to use Wu-li, Shi-li, Ren-li respectively to promote the success of construction management.

3.1 Wu-li

Wu-li is laws and rules that expound the natural objective phenomena and existence. It is expressed by equation, data, description, and other methods and need to be true (Zhang and Sun 2001). In the construction management process, Wu-li is the foundation which includes following goals.

1. Clear construction goals. Be familiar with the construction drawings, relevant technical standards and operational procedures; understand the design requirements, detail and node practices, and the requirements of relevant technical information to ascertain the quality of the project. Explore the geology, soil conditions, climate, hydrology and environment of construction site (Cao 2010).
2. Establish the execution plans. Be familiar with the construction organization design and the technical and economic requirements of construction sequence, construction methods, technical measures, and construction schedule and construction general layout. Normalize project goals of duration, resources and quality to determine the index of project construction.
3. Technical coordination. Coordinate the relationship between the construction technology and equipment machinery as well as building materials. Following the nature laws of these elements can smooth the construction process. Balance the relations between technology and environment of construction site like geology, foundation, traffic and water and electricity. Adjust measures to local conditions.
4. Recommendations. Once the tendency to deviate from the aim of the project emerges, constructors had better find the reasons from Wu-li aspect. If the Wu-li objects such as construction technology and equipment go wrong, timely feedback counts for much. Construction managers should take measures as soon as possible to prevent the construction from delaying in the schedule. If necessary, contacting designers and owners to resolve problems together is needed.

3.2 Shi-li

Shi-li means methods. It is the way that managers involve and execute the management of objects, including how to perceive, view, understand, think, describe and organize the object and process of management. As the means of construction management, Shi-li has four major goals.

1. Clear management objectives. First, construction leaders should organize programming and build teams. Team members need to understand the specific activities and responsibilities. Second, the project is required to be sure of the rational construction sequence according to the objective conditions. At last, estimate the time and resources of subproject and sub divisional work; develop construction budget and establish a set of perfect control system (Chinese Writing Committee of Associate Constructor Vocational Qualification Examinations 2011).
2. Execute the construction plan. As the project progresses and resource inputs increase, control the pace of construction and analyze and forecast the factors influencing the process are essential. One good method is to establish a set of standardized construction management system. In addition, set up a perfect contract system to ensure the construction process of the parties involved to abide by the rules and to prevent the act of one's own free will.
3. Knowledge coordination. Implementation of the organization and coordination of the target control is a very important work of construction management. Positive organizational equilibrium in every stage, every process and every construction tasks helps the construction of people, wealth, and all kinds of relations to keep the best combination. The construction will be ordered and efficient in this way.
4. Feedback. The Shi-li part like Planning, design and ecological protection is the key point of the successful project. In the construction process, supervisory staffs need to correct various detrimental operations at all time such as breaking rules and regulations, illegal violations of operation procedures etc (Sun 2010). In the case of the design and construction conditions change, managers should organize relevant personnel to revise and supplement the original construction scheme.

3.3 Ren-li

Dealing with the relationship between the parties excellently is Ren-li, and is also human science and behavioral science. Everything is inseparable from the people as well as judged by the people if these things and objects are proper. The coordination of all sorts of human relations is a learned skill. So the application of Ren-li guarantees successful targets (Gu and Tang 2006).

1. The leadership role of the project manager

In the traditional progress of project construction, the project manager is overall responsible for planning and implementation. As the team leader, project manager's first duty is to lead the project team to complete the project of high quality and on time within budget. Therefore, the project manager must be adept in integrating resources and grasp the problem from the whole, so as to seek the global optimal (Ding 2006).

Based on the traditional views, the WSR methodology lays more emphasis on the coordination ability and influence ability of manager. In the course of construction management, the owners, supervisors, constructors and even designers may clash because of different interests, ideas and relations. How to make everyone satisfied by compromising in conflicts tests the ability of project manager. In addition, when working in the construction management department or team, an excellent manager should deliver enterprise culture and value concept uniting knowledge and action (Zhou 2007). Considering the subjective factors of construction personnel mood like mood, psychological quality, attitude etc is essential because these elements can have a large effect on the constructors' work.

2. Both qualitative analysis and quantitative analysis

Quantitative analysis before the construction such as design drawings and construction organization design flow charts provide a template for the project construction. But the construction process is a dynamic, open process which needs to present empirical assumptions and judgments on the project, so as to pre-judge the direction, trend and transition of construction process. During the construction, different managers and experts put forward different proposals for construction because the construction management is interdisciplinary and interdisciplinary that needs group knowledge and wisdom. Relaying on the quantitative analysis only cannot propose group knowledge and wisdom, so it is necessary to combine qualitative analysis with quantitative analysis.

Through the human-computer interaction, repeated comparison and successive approximation, project participants realize wonderful effect from qualitative analysis to quantitative analysis, thus the clear conclusions will be made concerning the empirical hypothesis correct or not (Jin et al. 2010). In conclusion, coordinating the subjective initiative of people with accurate calculation again and again is the best way to optimizing the construction.

4 The Comprehensive Application of WSR

Wu-li, Shi-li and Ren-li interact with each other in the practice application. Any of them cannot be separated from others but at the same time each part has its own distinctive characteristics and plays different roles in field. Pay so much attention to the Wu-li and Shi-li that ignore the Ren-li makes people handle things mechanical as

Table 2 Relationship matrix of WSR steps (Zhang and Sun 2001)

Coordinating relations	(1) Understanding desires (2) Investigating conditions (3) Formulating objectives (4) Creating models (5) Implementing proposals (6) Evaluating performance

well as lake of feelings and passion. It may not reach the overall goal of the system, and even go in the wrong direction or being legality. However, emphasizing Ren-li against Wu-li and Shi-li also leads to failure (Gu et al. 2007). Therefore, the correct way is to combine with each other scientifically.

Handan County located in Henan Province of China spent nearly ten million to build a 4.5 km long tourist railway in 2010. But along the railway there are no spots available for viewing. Four months after the accomplishment, the railway had not been put into operation. Sightseeing railway is one of the key projects of Handan County, but according to the local people said, “Last December the train went over in the first test.”

This case is a typical failure project that heavies Ren-li but ignores Wu-li and Shi-li. In the process of construction, the subjective opinion of leaders and experts replaced the professional planning and scientific decision-making. Although the Ren-li is the fundamental dominance of man-made system, but as the all-important limiting factors, Wu-li and Shi-li are warrant for success. WSR is a unified process, and cannot be absolutely divided. It can be shown in Table 2 (Zhang and Sun 2001). Some steps may need to be repeated and some steps can also be taken in advance.

The construction management of China Guangzhou University town is a model of comprehensive WSR system methodology. Guangzhou University city covered an area of 18 km^2; its investment reached over 20 billion. Based on the WSR system, the construction emphasized the combination of qualitative analysis and quantitative analysis and established the work train of integration (She 2006). In the process of construction management, managers considered not only the advancement and applicability of technical factors, but also the current situation, organization structure, interpersonal relationships and other factors. The integrated use of multi-disciplinary talents and experiences and conjoint analysis of Wu-li, Shi-li and Ren-li make the construction management advanced and effective. Finally, the Guangzhou University town construction get consistent high praise, its unique construction management mode has also been recognized and promotion.

5 Conclusion

Any construction processes are not only composed by Wu-li, Shi-li and Ren-li, but also a dynamic process of interaction among them three. Successful construction management need to coordinate these three aspects and requires proper utilization.

With the development of construction management, for the attention and implementation of project, people has gradually concerned from Wu-li to Shi-li and ultimately to Ren-li. As a kind of system methodology, WSR provides a new theory, method and tools for the construction management, plays an important part in promoting scientification and systematization of construction management and is worthy of promotion and application.

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The Study of Urban Disaster Prevention and Reduction Planning

Zun-peng Yu and Hui-ying Gao

Abstract Right now, our country is in a period of rapid urbanization, the growing urban population size and economic development means we have to accelerate the pace of urbanization. But along with the step-up of urban construction, the problems of the urban disasters stand out as well. This paper studies the types of urban disaster, puts forward effective measures for urban disaster prevention and offers some opinions and suggestions from the perspective of disaster prevention and reduction.

Keywords Disaster preventing and reduction • Disaster prevention planning • Effective measures • Urban disasters

1 Introduction

With the deepening of our country's reform and opening up and the rapid development of our economy, the urbanization and city constructions in our country go into the period of fast development. But, the urban construction in our country mostly is expanding blindly, and lack of scientific, reasonable scientific and effective plan. The serious consequences caused by Wenchuan earthquake happened in 2008 left a painful memory to people. We should fully realize the essence of the urban disasters, do the job of urban disaster preventing and reduction well, establish an effective mechanism for disaster preventing and reduction, and take effective measures to avoid the occurrence of disasters or minimize losses.

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2 Methodology

2.1 The Nature and Types of Urban Disasters

The occurrence of urban disasters is related to the action and behavior activities of human beings closely, the natural climate and geological change cannot be called disasters if there no activities of human beings. So the system of urban disasters is composed of the intersected disaster-inducing network of "nature-social human-project" (Lei Jin 1992). The types of urban disasters mainly include:

1. Urban natural disasters include meteorological disasters and geological disasters, such as earthquake, tsunami, storm surge, typhoon, tornado, seawater intrusion, beach erosion, debris flow, flood, landslide, surface collapse, surface subsidence, place crack, fire disaster and so on.
2. "Constructive destruction" disasters which due to the negative effect of urbanization in China for 100 years, for instance, partial and local houses collapse, deaths and injuries, building and environmental disasters generated by subterranean construction, foundation pit and subway construction accidents; operation security of the municipal road and pipe network: pipeline break, pipeline explosion, coal gas and natural gas leakage (Jian Liu 2009).
3. New disaster sources, mainly include (1) the accident of high-tech system, nuclear accident disasters (2) urban public hazards or Urban ecological disasters, such as acid rain, lead pollution, allergenic pollen pollution (3) disasters caused by city emergency electrical equipment accidents (4) the risks of indoor disasters, such as electric shock, food poisoning, falling down the stairs and other events (5) "constructive destruction" disasters which due to human error, it specifically refer to the environmental disasters which caused by improper human activities, the blind exploitation of the nature without scruple. Compared with most of the natural disasters, it tends to causes the indirect potential damage, thus the humans do not take actions until they tasted the suffer (6) city epidemic disease disasters, the national city health disasters manifest as epidemic disease, tuberculosis, endemic disease, occupational disease, plague, schistosomiasis and so on (Lei Jin 1992).

2.2 The Importance of Urban Disaster Prevention and Reduction Planning

1. Urban disaster prevention planning can effectively anticipate a variety of possible disasters, doing our best to avoid the occurrence of disasters or reduce the harms when disaster occurs, which will lessen losses.

Detect and determined areas prone to geological disasters in urban planning, away from geological disasters zone, fully consider major hazard sources in urban planning, make sure that all of them can get effective and reasonable planning, avoiding the occurrence of disasters (Chang-fu Hong 2008). In July 21, 2012, Beijing suffered the strongest rainstorm and flood disaster in 61 years. The drainage capacity is inadequate because of it did not take such factors into account during the planning and construction of drainage system, which ultimately result in severe damage, including the death of 77 people. By contrast, in Paris, France, the world's most distinguished drainage system, which has a history of more than 150 years, is still at service and remains strong draining function, and mostly thanks to the scientific planning and construction.

2. Urban disaster prevention planning can strengthen the response capacity when disaster occurs.

Urban disaster prevention planning can provide us countermeasures which should be adopted when disaster occurs, so that we can be prepared in advance and cope with disasters timely and effectively. When we have been doing a good job of disaster prevention measures and disaster response, we can reduce losses when disasters occur, avoid too many casualties and economic losses.

3. Urban disaster prevention planning is an effective measure to promote the city develops steadily.

Urban disaster prevention planning plays a big role from the perspective of the sustainable development strategy of a city social economy, it not merely aiming at the problem of city infrastructure construction specially, but provides a very important safety guarantee to a city's development. In Japan, urban disaster prevention planning is required by the regulations in many large cities, the planning and design is not qualified and such construction is not allowed to start if urban design does not consider defensible space, or urban garden can't be refuge space at the same time, or the design of city lifeline system does not consider the reliability of standby strategy under the maximum state of emergency (China Construction News 2001).

Cities are likely to suffer significant losses in the event of major disasters, this loss may be difficult to recover in a short period of time, and the development of the city may be affected seriously.

2.3 Effective Measures for Urban Disaster Prevention and Reduction

1. Strengthening urban planning is an important means of disaster prevention and reduction.

The disaster prevention and mitigation is an important content of urban planning. Urban planning plays a very important role in urban disaster prevention and reduction. Urban disaster prevention and reduction needs comprehensive planning

Table 1 Functions of urban green land in disaster prevention (Jian-dong Zhou and Hao Wang 2008)

Green land type	Main function of disaster prevention
Attached green space (the green landscapes of residential district, the attached green space of school, institution and other organs)	Can be used as a temporary shelter, specific functionality includes: emergency refuge space, reduce the secondary disasters, temporary firefighting and medical assistance stations.
Park green space (all kinds of city parks including disaster-prevention Park, street greenbelt, waterfront green land and so on)	Can be used as center disaster-prevention park and fixed disaster prevention park, used for temporary shelter, evacuation resettlement victims.
Garden nursery, protective greenbelt, other green space	Used for temporary disaster-prevention park, emergency rescue channel, emergency shelters, fireproof forest belt, urban flood discharge alleyway.

and taking all factors into account, fully reflect the prevention and treatment of various disasters faced by the city in urban planning, especially in the planning of the development of urban industries, function layout, population density, public health, community safety and so on, to reflect the principles, requirements and measures for disaster prevention and reduction.

(1) Determine the scale of city and city space structure reasonably, avoid the natural disasters. Reasonable selection of urban construction land and controlling the size of cities are not only important means of disaster prevention and reduction, but also one of the key problems need to be solved in the urban planning. In the choice of urban construction land, do the job of land evaluation well, takes into account of terrain, geology, weather, the location of hazard sources, flood-control, seismic performance, wind-proof, among other factors. Try to avoid the disaster sources, implement the rationalization urban general layout.

(2) Plan the layout reasonably, avoid producing man-made disaster-prone zones. Major hazard sources, such as petrol service station, chemicals' storehouse, petroleum gas, need to be planning reasonably, select the location of construction scientifically, and reduce hidden security risks (Chang-fu Hong 2008).

2. Make full use of the emergency and disaster-prevention function of all kinds of urban green space.

According to the classification criteria of our country's Ministry of Construction in 2002, urban green space can be divided into five broad categories: park green space, garden nursery, protective greenbelt, attached green space, other green space. The functions of each kind of urban green land in disaster prevention can be seen in Table 1. Because of its location, area, service radius and the green nature differences, the status and requirements of different types of green space in urban disaster prevention system are different. At the same time, the disaster prevention facilities is the basis and guarantee of park and green space to enhance the function of disaster prevention, and is one of the most important condition to ensure the safety of refugee. Make full use of urban green space; establish a disaster prevention system of the city (Jian-dong Zhou and Hao Wang 2008).

Take the planning and design of disaster-prevention Park as an example. According to the actual requirements of disaster prevention and reduction, it can turn into a fixed disaster-prevention park when add the necessary disaster prevention facilities on the basis of municipal park. We should be rational develop, make effective use, fully guarantee the safety of the park, make sure that it is both conducive to the usual resident recreation and urban landscape ecological construction, and can be a refuge for all kinds of people when a disaster occurs (Jun-hao Jiang et al. 2008).

The planning principles of disaster-prevention park (Jun-hao Jiang et al. 2008)

(1) Security. Ensure the security of the emergency refuge and facilities, they must be far away from the seismic active fault and earthquake secondary disasters, especially the fire source.
(2) (Pedestrian) accessibility. The layout of the disaster-prevention park should be flexible and good for evacuation, the routine should be unobstructed for residents to reach and pass into the disaster-prevention Park.
(3) Hommization. Create the compatible and pleasant space and environment.
(4) Sustainability. Ensure the sustainability and long-term effectiveness of facilities and supplies in order to reduce the cost of disaster prevention and reduction and maintenance operating.
(5) Reasonability. Find the suitable point between Municipal Park and disaster-prevention Park.

3. Lifeline systems generally include four types: energy system, water supply and drainage system, transportation system and communication system.

There is strong correlation between lifeline systems; they affect each other after the disasters (Jun-zan Guo 2009). Lifeline system is one of the important supporting bodies of urban disasters, threatened by natural disasters, technological disasters, man-made disasters, the consequence has the characteristics of seriously damaged, wide spreading, severe social influence, secondary disasters seriously (Jian-xin You et al. 2006).

One the one hand, fully considering the capacity of the lifeline system is the important measure for a city to improve the disaster relief standard and ensure sufficient supply in peacetime. Besides, designers should increase the capacity of the lifeline system appropriately (Jiang-lin Xi et al. 2007). On the other hand, the advanced technology research of lifeline system monitoring, early-warning, detection and earthquake emergency response analysis method and the prevention control is extremely urgent. It's very important research work to establish lifeline intelligent digital disaster reduction engineering system of simulating the seismic disaster process, damage character, disaster distribution and the decision of disaster reduction (Hong-nan Li and Chun-guang Liu 2005).

4. Make the most of new technologies such as geographic information system to improve the organization and management level of urban prevention planning (Zhong Chen 2009).

Data management is of vital importance to the study of disaster prevention, GIS is the software technology of expressing, processing professional data related to the geographical distribution, has been widely used in the study of urban disaster prevention emergency. GIS can be used to manage urban fundamental information, manage and analyze urban disaster source and hazard sources, provide disaster loss prediction when disaster occurs, and combined with field condition in the decision to choose the best relief path, make reasonable scheduling of relief supplies and disaster relief plans, provide the information for command decision of disaster relief (Ting Wang et al. 2012).

5. Improve the anti-disaster ability of the existing engineering of the city.

Strengthen the supervision management of engineering disaster-prevention construction, constantly develop new engineering construction technology, and improve the calamity resistance of architecture structure. Repair and strengthen existing engineering.

6. According to the type of disaster, establish an effective disaster management and reduction system, which can be used for disaster monitoring, disaster forecast, disaster prevention, disaster response, disaster relief and post-disaster reconstruction (Feng 2005).
   (1) Disaster monitoring, include disasters precursor monitoring, disaster trend detection.
   (2) Disaster forecast, including the potential hazards, and occurrence time, scope, scale and prediction, to prepare for the effective prevention. For example, in 1975, earthquake prediction workers forecasted the Haicheng earthquake successfully, and saved tens of thousands of people's lives.
   (3) Disaster prevention, take evasive measures against natural disasters; this is minimum-cost and remarkable prevention measures.
   (4) Disaster response, this refers to engineering measures taken to against disasters.
   (5) Disaster relief, this is the most urgent measures when a disaster has begun or after the disaster.
   (6) Post-disaster reconstruction. The accurate disaster assessment is one of the most main bases of post-disaster reconstruction, the recovery of production and social life in disaster areas is also important disaster reduction measures.

7. Set up the disaster prevention and reduction basic legal system in our country.

Set up the disaster prevention and reduction basic legal system which should be universally applied in our country. On the whole, it should clearly define the responsibility, content and measures of disaster prevention and reduction. Establish a unified observation, forecast and emergency relief organization system; regulate the disaster prevention behavior of all ranks of society (Gui-ping Chen 2004).

Urban disaster prevention system should be dynamic and open, constantly update information, achieve the unity of the timeliness and effectiveness, using the new experience and technology to improve disaster prevention plan.

2.4 Advice to Citizens' Awareness of Disaster Prevention

The old idea of paying more attention to disaster relief than disaster prevention and taking action after disasters happened in China formed in the disaster management conception result in long-term non-coordination of material input in disaster prevention and reduction. Emergency response of post-disaster makes limited investment can't fully played its role in disaster prevention and reduction, weakened the ability construction of disaster prevention and reduction (Gui-ping Chen 2004).

Make sure the residents are not panic when disaster occurs by establishing the awareness of disaster prevention, let people learn to cope with sudden disaster. Residents' ability of coping with sudden disasters crisis and psychological endurance is generally poor in our country, the ability of self-aid and buddy-aid during a disaster is even worse. Thus, establishment of public security education base which citizens can visit and experience freely in the big city is required. Introduce all kinds of disasters to them, teach them the effective measures of disaster prevention, and let them know how to take the pre-disaster effective defense and how to respond when disaster occurs. Set up urban disaster relief fund, it can't rely entirely on the government in the disaster relief work; turn the temporary contributions into the long-term disaster relief organization (Guang-wei Wu et al. 2006).

3 Conclusion

Urban disaster prevention and reduction planning should be treated in professional view, we should establish effective measures with modern advanced engineering techniques, make full use of information technology means, learn from foreign countries and draw on their experience, and put the plan into practice. But in addition to strengthening urban disaster prevention and reduction planning, we should take our actions according to natural laws, try to avoid the occurrence of natural disaster and man-made disaster which due to the improper human behavior.

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The Study on the Selection of Industrial Undertaking and Spatial Arrangement of Hebei Province

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Abstract To undertake industry transfer scientifically, reasonably and effectively can improve the technological level, optimize the industrial structure, enhance the regional competitive advantage, as well as promote the development of region economic. This article uses the industrial gradient theory based on the condition and characteristics of Hebei industrial transfer, aiming at Hebei 28 manufacturing to do the quantitative analysis. Based on the results of the analysis, eight industries have been chosen to give priority to undertake, then classify these eight industries into four different oriented industries, based on the different needs of each industry and with the condition of Hebei regional industry development, we have give advice to the spatial arrangement of the undertaking industry.

Keywords Industrial transfer • Industrial selection • Industrial gradient • Spatial arrangement

1 Introduction

Industrial transferring is the inevitable outcome of the economic development and is also a dynamic adjustment process of optimum distribution of worldwide resources, what is more, it is a good way to narrow the gap between regions, urban and rural, the rich and the poor (Ma Zihong 2009). To undertake industry transfer scientifically,

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reasonably and effectively can improve the technological level, enhance the regional competitive advantage, as well as to promote the development of region economic (Kojima 2000). While when the industry undertaking region neglect the matching condition just draw the industrial transfer or to offer so much preferential policy, it will emerge cut-throat competition which is bad for the region industrial structure adjusting and upgrading (Dai Hongwei 2008).

At present, with the development of the regional economic integration, Beijing-Tianjin-Hebei region has become a huge engine to pull China's economy after PRD and the Yangtze Delta. To propel the progress of Beijing-Tianjin-Hebei regional integration, cooperation and coordinate distribution in needed. What is more, to adjust and upgrade the industrial structure as well as narrow the gap between regions is also necessary (He Lisheng and Wang Guixia 2006). Hebei province is an important part of Beijing-Tianjin-Hebei region integration, it holds all the aces to undertake Beijing and Tianjin's industry (Zhao baowei 2006). Achieving the industry transferring of Beijing-Tianjin-Hebei region successfully is not only the need of Beijing-Tianjin-Hebei region's advanced development but also the need of optimization of industrial structure for Hebei province (Qing Zunwen and Zhao Xia 2008; Smith 2003). This article will give the industry undertaking selection and distribution advice for Hebei province with the trend of Beijing and Tianjin industry transfer, on the purpose of realizing the industry structure optimizing and advancing as well as achieving the win-win goal (Hill 2000).

2 The Condition and Characteristics of Hebei Industrial Transfer

2.1 The Condition of Hebei Industrial Transfer

At present, under the influence of market discipline and the need of regional industry upgrading, the rapid economic development region has frequently transfer some traditional industry. Hebei province relies on its unique regional advantages, to explore the cooperation for industry transfer and enterprise spanning districts with Beijing and Tianjin actively. For example, Beijing, under the restriction of its function orientation and resource endowment as well as environmental requirement, such Metallurgy, Building Materials, and Chemical industry all have been transferred to Hebei related region. According to incomplete statistics, since Beijing has bid for Olympics successfully, there are about 1,000 enterprises transferred to the Hebei cities, among them, the largest scale is the Capital Iron and Steel Company moved to Caofeidian, Tangshan, which is regarded as the hallmark event for Beijing and Hebei industry transfer.

Meanwhile, Beijing and Hebei jointly promote the development of Jingjintang high and new technology industry area, build the barrier-free development demonstration area for the circle of Beijing-Tianjin-Hebei metropolitan regional collaboration. Both sides have strengthened the guide for Caiyu Beijing, Zutuan Yongle and Langfang Hebei' cooperation. Increase the input of infrastructure construction in these areas, to realize the reasonable distribution of regional cooperation framework of urban function, to make it be the important function area for capital industry distribution, population and city serve as well as the training base for high skill talents (Patchell 1996). There are 115 projects connect Beijing and Zhuozhou economic and technological development zone. As the "Beijing south protect Beijing" Equipment manufacturing base, Zhuozhou pine shop industrial park, there are nine projects be put down.

2.2 The Characteristics of Hebei Industrial Transfer

1. Hebei undertaking industry is mainly Steel, Metallurgy, Machine manufacturing, Food processing and such traditional manufacturing.
2. The industries Beijing and Tianjin have transferred out are mainly resource consumed, focus on Heavy Chemical industry, Spinning industry and general Processing industry (Ranis 2004). Such as Capital Iron and Steel Company, Beijing coking plant, the first machine tool plant foundry, these projects have big demand for coal, steel, and water.

3 The Analysis of Hebei Undertaking Industry Selection

Based on the condition and characteristics of Hebei province, considering the development trend of Hebei industry, this article have selected 28 manufactures to be the object of study according to the <national industries classification>(GB/T4754-2002), rejected Waste resources, Waste material recycling industry, Tobacco manufacturing industry and Weapons and Ammunition manufacturing.

3.1 Research Method

In order to guarantee the integrity, rationality, comprehensiveness and systematicness of the result, this article uses the industrial gradient transfer coefficient to do the quantitative analysis and make judgments. This article makes location quotient, Comparative Labor Productivity and comparative capital rate, these three factors, into consideration. location quotient reflect the industrial degree of specialization and measure the regional comparative advantage, the Comparative

Labor Productivity reflect the technological level, such as workers' quality and comprehensive technical level, the comparative capital rate can reflect the capital profitability, multiply the three result as the Industrial gradient coefficient. Namely:

$$\begin{aligned}&\text{Industrial gradient coefficient} = \text{Location}\\&\text{Quotient} * \text{Comparative Labor}\\&\text{Productivity} * \text{comparative capital rate}\end{aligned} \tag{1}$$

$$\begin{aligned}&\text{Location Quotient} = \text{the proportion}\\&\text{a sector's regional industrial added}\\&\text{value account for the regional}\\&\text{GDP/the proportion this sector's national}\\&\text{industrial added value account for GDP}\end{aligned} \tag{2}$$

$$\begin{aligned}&\text{Comparative labor productivity} = \text{the proportion}\\&\text{a sector's regional industrial added value account}\\&\text{for the sector's national industrial added}\\&\text{value/the proportion the employees in the sector}\\&\text{in this region account for the employees in}\\&\text{the same national sector}\end{aligned} \tag{3}$$

$$\begin{aligned}&\text{Comparative capital rate} = \text{the proportion}\\&\text{a sector's regional industrial added value}\\&\text{account for the sector's national industrial}\\&\text{added value/the proportion the average}\\&\text{capital in the sector in this region account}\\&\text{for the average capital in the same national sector}\end{aligned} \tag{4}$$

Among them, Location Quotient is the indicator to measure the regional production specialization level and reflect the degree of specialization, if Location Quotient>1, it means the level of the specialization is high in this area and the comparative advantage is strong, the industry should be transferred into this area, on the contrary, the industry should be transferred out. Comparative Labor Productivity<1, it means the level of this industry is lower than average level nationwide, the industry should be transferred out, on the contrary, the industry should be transferred into this area; Comparative capital rate is similar to Comparative Labor Productivity, which also reflect the regional level compared to national level, this rate reflect the capital profitability. If the rate >1, it means the level of capital profitability is higher than the national level, the industry should be transferred into this area, on the contrary, the industry should be transferred out.

All in all, the industry transfer is always from the week ability region to the strong. So, Location Quotient, Comparative Labor Productivity, Comparative capital rate and Industrial gradient coefficient>1, it means under all the indicators, the area has much advantage in this industry compared to the national level, this industry should be transferred into this area, On the contrary, the condition is the opposite.

3.2 The Source of the Data

This article analysis 29 manufacturing industry, all the data is from Hebei Economic Year Book (2006–2012), The Chinese counties social-economic Statistical Yearbook of 2005–2012 the price in 2000 is regarded as the constant price (Hebei Provincial People's 2006; State Statistics Bureau 2006).

3.3 The Empirical Study of Hebei Undertaking Industry Selection

This article uses the industry gradient index formula, reached 2009–2011 Hebei industry gradient index and the average industry gradient index (shown in Table 1) with EXCEL software (Hebei Provincial People's 2000).

The higher industry gradient index means the higher gradient in the whole nation, the level of the industry development is higher. The higher Location Quotient and Comparative Labor Productivity mean the possibility of undertaking other region's industry. According to industry undertaking condition, the industry with high gradient coefficient and the industry with low gradient coefficient or develop potential (Table 2).

For this reason, in the process of the economic development, Hebei province should give priority to such undertaking industry: Computer communications equipment and other electronic equipment manufacturing industry; Textile and apparel shoes cap manufacturing; The ferrous metal smelting and rolling processing industry; fur manufacturing; Metal product industry; Food Processing; Instrumentation and cultural office machinery manufacturing; Cultural Educational and Sports Goods.

4 The Spatial Arrangement of Hebei Province Undertaking Industry

The relevance between spatial arrangement and FDI is closely, the spatial arrangement of industry undertaking is one of the manifestations of investment. So this article has classified the undertaking industry into four types according to the

Table 1 The sectors' industrial gradient coefficient in Hebei

	Location quotient	Comparative labor productivity	Comparative capital rate	Industrial gradient coefficient	Order
Farm and sideline products processing	0.79	1.33	0.03	0.04	5
Food manufacturing	0.76	0.96	0.03	0.02	10
Beverage manufacturing	0.47	0.76	0.02	0.008	22
Textile industry	0.73	1.09	0.04	0.03	6
Textile shoes and cap manufacturing	0.35	1.14	0.02	0.008	23
Fur manufacturing	1.16	2.37	0.08	0.22	2
Wood processing	0.56	1.70	0.02	0.02	11
Furniture manufacturing	0.45	1.25	0.02	0.01	17
Paper manufacturing	0.67	1.01	0.05	0.03	7
Printing and record medium reproduction	0.63	1.30	0.03	0.02	12
Cultural educational and sports goods	0.33	2.22	0.04	0.03	8
Oil processing and coking and nuclear fuel processing industry	0.61	0.50	0.03	0.01	18
Chemical raw materials and chemical products manufacturing	0.75	0.95	0.04	0.03	9
Medicine manufacturing	0.56	0.59	0.02	0.006	24
Chemical fiber manufacturing	0.19	0.31	0.02	0.001	28
Manufacture of rubber	0.85	0.95	0.08	0.06	4
Plastic product industry	0.52	1.26	0.03	0.02	13
Nonmetal mineral products	0.70	0.73	0.03	0.01	19
Ferrous metal smelting and rolling processing industry	11.79	3.91	0.23	10.57	1
Non-ferrous metal smelting and rolling processing industry	0.28	0.87	0.02	0.005	25
Metal product industry	1.38	1.77	0.06	0.14	3
Ordinarily machinery manufacturing	0.65	0.88	0.04	0.02	14
Special equipment manufacturing	0.61	0.82	0.03	0.02	15
Transportation equipment manufacturing	0.37	0.60	0.02	0.005	26

(continued)

Table 1 (continued)

	Location quotient	Comparative labor productivity	Comparative capital rate	Industrial gradient coefficient	Order
Electric equipment and machinery Manufacturing	0.51	1.32	0.02	0.01	20
Computer communications equipment and other electronic equipment manufacturing industry	0.18	1.27	0.01	0.003	27
Instrumentation and cultural office machinery manufacturing	0.33	1.40	0.02	0.01	21
Craftwork and other manufacturing	0.44	1.46	0.02	0.02	16

Table 2 The indicators of which sectors are more than one in Hebei

Location quotient	Fur manufacturing; ferrous metal smelting and rolling processing industry; metal product industry
Comparative labor productivity	Farm and sideline products processing; textile industry; textile shoes and cap manufacturing; fur manufacturing; wood processing; furniture manufacturing; paper manufacturing; the replication of printing and recording medium; cultural educational and sports goods; plastic products; the ferrous metal smelting and rolling processing industry; metal products; electric equipment and machinery manufacturing; computer communications equipment and other electronic equipment manufacturing industry; instrumentation and cultural office machinery manufacturing; handicrafts and other manufacturing
Industrial gradient coefficient	Ferrous metal smelting and rolling processing industry

invest purpose: natural resources orientation, labor force orientation, technology orientation and industrial base orientation. The article has classified 11 industries, which are shown in Table 3.

4.1 Natural Resources Orientation

4.1.1 The Ferrous Metal Smelting and Rolling Processing Industry

Hebei province is rich in mineral resources especially iron ore. With the advantage of rich resource, metallurgical mining has become the lead of leading industry and is the strongest power to pull the industrial economy growth. Hebei market share

Table 3 The types of the undertaked industries in Hebei

Types	The name of industry
Nature resource	The ferrous metal smelting and rolling processing industry
	Farm and sideline products processing
Labor force	Textile and shoes cap manufacturing
	Fur manufacturing
Technology	Communication of computer and other electronic equipment manufacturing industry
	Instrumentation and cultural office machinery manufacturing
Industrial base	Cultural educational and sports goods
	Metal products

of ferrous metal casting and steel rolling processing is about 15.5 % which is the first in the country. Considering the restrictions of the content of iron ore resources, this industry is obviously restrained by the nature resources. For this reason, there are two models for this industry's distribution: One is located near the old industrial bases which is rich for raw materials (rich iron ore resources), such as Luanping County and Wu'an country. Another is located near new industrial bases which are closet to the ocean; the water resources and port resources are rich, market at home and abroad are vast. Such as, the industrial zone of Caofeidian.

4.1.2 Farm and Sideline Products Processing

Farm and Sideline Products Processing is labor-intensive farming industry based on agricultural fishery products. Its development depends largely on the plenty of the agriculture products, preservation condition supply properties and the labor force and other factors. When the enterprise look for the investment district, firstly it should pay more attention on the condition of the agriculture products, so the places which have advanced planting industry, animal husbandry and fishing and is good for acquiring materials should give priority. In the second place, the level of infrastructure, hydroelectric, communication, storage, physical distribution offers the guarantee for the regional development. The full equipped infrastructure is also an important requirement to draw big projects. With the acceleration of the capital and technology intensive Industry transfer tide, the demand for the labor force quality is higher than before, abundant labor force is the precondition for the industrial undertaking. Based on the profit maximization, Slaughtering and meat processing enterprise can be transferred to Lingshou county, Xingtang county, Gaocheng county, Shunping county, Gu'an county and Mancheng county; The processing of fruits, vegetables and nuts enterprise can be transferred to Yongnian county, Qianxi county, Shunping county and Mancheng county; Aquatic products processing enterprises can be transferred to Tangha county, Laoting county, Changli county and Haixing county.

4.2 Labor Force Orientation

4.2.1 Textile Apparel, Shoes and Cap Manufacturing

Textile apparel, shoes and cap manufacturing is one of the pillar industries of Hebei province. In 2011, there are 203 Textile apparel, shoes and cap manufacturing enterprises and 58.7 thousand employees in Hebei, the total industrial output value is 28.804 billion yuan, and the total assets is 11.093 billion yuan. In recent years, under the support of superior resources and cheap labor power, textile industry has increased rapidly. This industry can be easily affected by the labor force resources. With the improvement of the social and economic development, the cost of labor force, energy and raw materials rise (Lewis 1954). Based on the Act-utilitarianism, enterprises should transfer to the region with abundant labor force, low prices and good industrial foundation. Such as Ningjin, Rongcheng and Gaoyang County, make full use of industrial concentration effect to form the industrial concentration based production pattern.

4.2.2 Leather Fur Feathers (Fine Hair) and Its Products

Leather fur feathers (fine hair) and its products is the competitive industries in Hebei province, in this industry, Hebei is worthy of its name: the only one provincial fur industry association is set up; it owns the whole industry system including cultivation-market-process and domestic trade sales as well as the accelerated serve system. In recent years, under the support of superior resources and cheap labor power, Leather fur feathers (fine hair) and its products industry has increased rapidly. With the improvement of the social and economic development, the cost of labor force, energy and raw materials rise, this industry can be easily affected. Based on the Act-utilitarianism, enterprises should transfer to the region with low cost. Therefore, there are two models for distribution: one is to make most use of the successful fur producing base, such as Xinji, Zaoqiang, Lixian, Yangyuan, Gucheng and Nangong. Another is to locate near the region with abundant raw materials and low costs, such as Zhangjiakou, Chengde, Cangzhou, Qinghuangdao, in order to integrate production and processing.

4.3 Technology Orientation

4.3.1 Computer Communications Equipment and Other Electronic Equipment Manufacturing Industry

Computer communications equipment and other electronic equipment manufacturing industry belong to the high-technology sectors and is one of the industries to foster for Hebei province. So far, there are four characteristics of this industry: firstly, solar photovoltaic industry develop vigorously; secondly, basic products has prominent dominant; thirdly, semiconductor lighting industry shows the potential; fourthly, software and information service keeps the good momentum. Computer communications equipment and other electronic equipment manufacturing industry is the type of technology-intensive industry, technology is the important force for its development, Industrial Research Institute, universities, originality mass, enterprises play an important role in the development of this industry. So when the enterprises select the investment region, they should pay more attention on the technology foundation, industry chains and the condition of human resources. Only with the support of the good technology foundation, accelerated industry chain and abundant human resource, enterprises can realize the goal of low costs and maximum profit (Baptista 2000). Considering all above, Shijiazhuang, Langfang, Qinghuangdao, Baoding, Tangshan can be brought into consideration.

4.3.2 Instrumentation and Cultural Office Machinery Manufacturing

Instrumentation and cultural office machinery manufacturing can be divided into five categories: Universal instruments manufacturing, Dedicated instrumentation manufacturing, Horological and chronometric instruments manufacturing, Optical instrument and glasses manufacturing and other. Instrumentation and cultural office machinery manufacturing is the type of technology-intensive industry, technology is the important force for its development, Industrial Research Institute, universities, originality mass, enterprises play an important role in the development of this industry. So when the enterprises select the investment region, they should pay more attention on the technology foundation, industry chains and the condition of human resources. Only with the support of the good technology foundation, accelerated industry chain and abundant human resource, enterprises can realize the goal of low costs and maximum profit. Considering all above, Cangzhou, Shijiazhuang, Tangshan and Baoding can be brought into consideration.

4.4 Industrial Base Orientation

4.4.1 Cultural Educational and Sports Goods

With the development of economics, Cultural Educational and Sports Goods is the emerging industry and is endowed with new meaning by traditional industries. Cultural Educational and Sports Goods is the emerging industry with new technology and new materials combined with traditional industries. The industry is characterized by high technology, high intelligence, high profit and low consumption, low pollution. The main products are track and field items, paint clip, drawing board and special laboratory equipment, instrument, experimental apparatus as well as fitness equipment. The industries have changed the old distribution and begin to move to the region with high technology, abundant raw materials. The industry is based on materials and led by technology, so when the enterprises select investment region, they should firstly consider raw materials and the industrial foundation, then technology. The technology foundation and strong technical force is the key factor for further development. All above, Shijiazhuang, Baoding and Caozhou can be brought into consideration.

4.4.2 Metal Products Industry

Recently, Metal Products industry has been regarded as the leading industry to foster and metal products industry is the most important one in the seven equipment manufacturing industry. It is the downstream of equipment industry and is the important part of steel deep processing. Recently this industry has small capital scale, is lack of talents and is lag in technology. So it is important to introduce technology and talents to lengthen the industry chain and promote profit. This industry has high demand for the local industry foundation and should locate near raw materials. So the appropriate cities are Shijiazhuang, Hengshui, Cangzhou and Langfang.

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Analysis of Construction of Large Infrastructure Projects Based on PPP Mode Through Cooperative Game

Yi Leng and Hao Wang

Abstract PPP mode is an importance development direction of large public infrastructure projects. Based on the cooperative game analysis, this paper designs optimal income distribution model for construction of PPP projects. It concludes that the income distribution of each participant is the key to the success for large infrastructure construction. Through cooperative game relationship between government departments and private enterprises in the process of contract negotiations, I think the income of participants of large infrastructure projects affected by the bargaining power and risk preference under the condition of market. Finally, we make the corresponding conclusion and suggestion combined this model.

Keywords Cooperative game • Income distribution • Large infrastructure projects • The PPP mode

1 Introduction

With economic development, the demand for large public infrastructure construction is increasing day by day. The traditional development pattern, which the construction is funded by the government, will inevitably lead to tension funds. The kind of situation may also lead to supply of large public infrastructure with seriously insufficiently, and affect the scale and quality of projects negatively. This will not be able to meet the needs of residents under the trend of economic development. Therefore, it becomes an inevitable trend that the government partner with the private sector to seek more access to funds and improve technology strength and administration ability together. With this background, the PPP mode (Public-Private

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Partnerships) has been introduced to the construction of public infrastructure with its own advantages like low cost and high efficiency. For example, the Beijing National Stadium, also known as the bird's nest is a classic engineering case based on PPP model.

The Discusses of the public infrastructure based on PPP model have never been interrupted. Scott Fosler (1978) studied seven representative American cities attracted the private sector to ensure effective provision of public goods with the help of the PPP mode. They pointed out that people should choose a feasible cooperation scheme about PPP mode fitting the local economic structure and political system (Fosler 1978). M. M. Hackbart and J. R. Ramesy (1992) believes that growing responsibilities of government in infrastructure finance has led to an enhanced emphasis on capital budgeting and on developing new initiatives in the capital financing arena, which have impacted the traditional roles of state and local governments in many areas. So PPP model should be a reasonable way of financing is widely accepted by government (Hackbarta and Ramseyb 1992). M. Li (1994) argues, with the economic development, costs of large infrastructure projects increased rapidly because the size and professional demand of facilities is becoming higher and higher. Partnerships between public sector in the form of government and private sector in the form of private enterprises aim to raise funds together, which is a low-risk way should be promoted (Li 1994). Darrin Grimseya and Mervyn k. Lewis (2002, 2004), however, show that the operating mechanism of PPP mode is complicated. At the same time, It will causes higher requirements of risk control. This is the current major problems hindering the development of the PPP model (Grimseya and Lewis 2002, 2004). Bovaird (2004) and Hodge and Greve (2007) analyzed the current development and the impact on cost and performance of PPP model in the United States and Europe. Through these analyses, they argue that the PPP model can reduce the cost of large projects (Bovaird 2004; Hodge and Greve 2007). Robin Ammon (2007) and Michael J. Garvin (2010) believe that the reformation of basic establishment run by civilian such as PPP model is the future development trend, if there were a perfect legal guarantee system (Ammon 2007; Garvin 2010). E. Iossa and D. Martimort (2008, 2012) analysis highlights the costs and benefits that bundling planning and implementation—as under PPP model—possibly allowing for asymmetric information, moral hazard and renegotiation. They also shows that relying on private finance enhances the benefits of bundling only if lenders have enough expertise to assess project risks (Iossa and Martimort 2008, 2012).

However, construction of large infrastructure projects based on PPP model is not only a simple cooperation, in my mind, its essence is the process of negotiation for the joiners to achieve some interest goal. PPP model involve multiple participants, negotiation with each other is a typical game process. A successful PPP cooperation is necessary to reach game equilibrium. However, the past researches were more about qualitative analysis and theoretical description while quantitative analysis was rarely introduced to this subject. And none of these articles use the method of game theory to quantitative analysis the game behavior. All this heavily limits the depth and precision of research. Drew support from the game theory to study the relationship of returns and risk among various participants in the construction of infrastructure projects and the main factors affecting the behavior of these participants, this paper aims to provide a first attempt to establish an optimal mode of income distribution based on PPP model between all parties. The paper can provide theoretical guide for applying PPP model in the infrastructure. It will be useful at facilitating the healthy development of public economy.

2 Income Distribution Model

The PPP model is essentially a kind of cooperative construction management mode, operation is based on a series of agreements between participants (Grossi 2007). Therefore, an optimal mode of income distribution based on PPP model, in my opinion, can guarantee the stable services for public facilities construction. The main factors of scientific income distribution scheme include the following:

1. *Bargaining power*: The rights and relationship of the income distribution of all parties reflected in the design of contracts, even if the course of the establishment of contract about income distribution without a negotiation process. In other words, final decision of income distribution depends on the balance of power and the final game result of each other.
2. *Risk appetite*: Different degrees of risk appetite affect the negotiating skills of participants. After that, this paper provides a mode as following.

A cooperative game between the project participants is $(N, R(S))$, N is a collection of all the participants in the construction project. $S \subseteq N$ is sub-alliances of all the participants, which is a subset of N. Members of sub-alliances S can get uncertain revenues, which can also be called stochastic payoffs is indicated by $R(S)$, if they cooperate. $R(S) \in [r_1, r_2]$, meaning that total revenue can be controlled within a certain range. The distribution of stochastic payoffs can be written as $p_i R(S)$, $\sum p = 1$.

2.1 The Boundary of Alliances Income Distribution

First, we standardize the boundary system of the income distribution. Improvement of own interest is the premise of participants cooperate (Nash 1953; Harsanyi 1963). All of the income distribution or cost sharing has to be based on this prerequisite. So, we can establishes a boundary condition of cooperative game $(N, R(S)(\succ_i)_{i \in N})$ as the requirement that

$$\begin{cases} p_i E\left(R(N)\right) \geq E\left(R(i)\right) \\ \sum_{i \in S} p_i E\left(R(N)\right) \geq E\left(R(S)\right) \end{cases} \tag{1}$$

It is impossible for alliance to bring additional benefits to all members and cooperation is also impossible to achieve, if the conditions in (1) are not set up. It reaps a quantifiable reward that can be written as $y = E(R(N))$ after project completion. Moreover, this article assumes that participant i has an irreplaceable resource x_i as to simplify the model. So y can also be written as:

$$y = f\left(x_1, x_2, \ldots, x_n\right) \tag{2}$$

Coefficient c_i is the economic cost of x_i. That can create extraneous income π, which is total income minus total economic cost because of cooperation:

$$\pi = y - c_1 x_1 - c_2 x_2 - \cdots - c_n x_n \tag{3}$$

Assumes that, in the league, member i can reap the share of extraneous income is α_i. If member i joins this alliance, total income of i can be defined by y_i:

$$y_i = c_i x_i + \alpha_i \pi, \quad \sum_{i=1}^{n} \alpha_i = 1 \tag{4}$$

If α_i less than 0, as well as y_i less than $c_i x_i$, according to (1), the member i would choose to exit and separate operation. Thus, $\alpha_i \in (0,1)$. If a member of the alliance leave the project construction, the alliance has to purchase productive factor from market as substitution, and the cost is called repurchase cost in this paper, denoted by ξ. The bigger the ξ_i is, the more replacement cost of the member i would be paid. In other words, member i has the low degree of substitution, if ξ_i is large. If member i in the league don't cooperate and as a project sponsor seeking partners for the same project construction, it can get benefit, which is denoted by $y_i^{'}$:

$$y_i' = c_i x_i + \pi - \sum_{j=1}^{n \backslash i} \xi_j x_j \tag{5}$$

Moreover, the condition of coordination between the member i and the existing alliance is $y_i \geq y_i^{'}$. Otherwise, the members i would pull out of the existing alliance. It can be represented as:

$$y_i \geq \max\left(c_i x_i, y_i'\right) \tag{6}$$

Through (6), we can get the basic conditions of cooperation:

$$\begin{cases} \alpha_i \in (0, 1) \\ \alpha_i \geq 1 - \dfrac{\sum_{j=1}^{n \backslash i} \xi_j x_j}{\pi} \end{cases} \tag{7}$$

Further, we can get such a result that:

$$\alpha_n = 1 - \sum_{i=1}^{n-1} \alpha_1$$
$$= 1 - (n-1) + \frac{(n-2)\sum_{j=1}^{n-1} \xi_j x_j + (n-1)\,\xi_n x_n}{\pi} \tag{8}$$

Using (7) and (8), this becomes:

$$\sum_{i=1}^{n} \xi_i x_i \geq \pi \tag{9}$$

Conclusion 1: Gross income of all the participants in the alliance is not lower than the cost of inputs, which is the boundary of alliances income distribution based on PPP model. Compared with the traditional construction mode, successful collaboration based on PPP model will save social cost.

2.2 *Optimal Income Distribution Model*

After theoretically proving the advantages of the PPP cooperation, for participants, it is more concerned about specific profit value (i, e, use coefficient α) in this range. Obviously, in the process of the contract negotiations, participants have different levels of power of discourse within the alliance. Accordingly, the bargaining power is also different. In market economy, repurchase cost may be taken as the measurement index for the bargaining power. Because, the degree of substitution determines confidence level of leaving the existing alliance as participants are not satisfied with income distribution scheme. If some factors can be replaced easily in the market, a threat to quit will be pretty hollow. So the purchase cost is proportional to the bargaining power:

$$t_i = b\xi_i, \quad \sum_{i=1}^{n} t_i = 1 \tag{10}$$

Coefficient t refers to the bargaining power, b is a real number greater than 0. In addition, we temporarily assume that alliance members are risk neutral participants in this article. According to Nash equilibrium model, in order to maximize utility of cooperation, we confirm the income share of the distribution through maximizing "Nash product" (Zhoula Lu 2009). It can be expressed as follows:

$$U = \left(y_1 - y_1'\right)^{t_1}\left(y_2 - y_2'\right)^{t_2} \cdots \left(y_n - y_n'\right)^{t_n} \tag{11}$$

Logarithmic form of (11):

$$\ln U = t_1 \ln\left(y_1 - y_1'\right) + t_2 \ln\left(y_2 - y_2'\right) + \cdots + t_n \ln\left(y_n - y_n'\right) \tag{12}$$

Obviously, finding the maximum of (12) is equivalent to maximum of (11). To strive partial derivatives of the equation and makes it equal to zero. It can be calculated that:

$$\begin{cases} \alpha_i = \frac{t_i}{t_j}\alpha_j - \frac{t_i}{t_j} + 1 + \dfrac{\frac{t_i}{t_j}\sum\limits_{h=1}^{n\backslash j} \xi_h x_h - \sum\limits_{h=1}^{n\backslash i} \xi_h x_h}{\pi} \\ \sum\limits_{i=1}^{n} \alpha_i = 1 \end{cases} \tag{13}$$

When repurchase cost of the inputs of member i infinite approximating 0, as well as $\xi_i \to 0$, we can conclude that:

$$\lim_{\xi_i \to 0} \alpha_i = 1 + \frac{-\pi}{\pi} = 0 \tag{14}$$

According to (14), if repurchase cost of the members is zero, their bargaining power is almost non-existent. In such a case, the member will hardly enjoy extraneous income because of the alliance cooperation.

On the contrary, When repurchase cost of the inputs of all others infinite approximating 0, as well as $\sum\limits_{j=1}^{n\backslash i} \xi_j \to 0$, the repurchase cost of member i infinite approximating π because of (9). It can be written that

$$\lim_{\xi_i x_i \to \pi} \alpha_i = 1 \tag{15}$$

In general, however, the repurchase costs of factors which are controlled by each member of the alliance in construction are greater than zero – that is, $\xi_i > 0$, $i \in n$. Moreover, using (13), we can know that:

$$\frac{\partial \alpha_i}{\partial \xi_i} = \frac{(n-1)\sum\limits_{j=1}^{n\backslash i} \xi_j \left(\sum\limits_{j=1}^{n} \xi_j x_j - \pi\right) + (n-1)\,\xi_i x_i \sum\limits_{j=1}^{n} \xi_j}{\pi\left(\sum\limits_{j=1}^{n} \xi_j\right)^2} \tag{16}$$

Using (9) and (16), we can get following result that:

$$\frac{\partial \alpha_i}{\partial \xi_i} > 0, \quad \frac{\partial \alpha_i}{\partial \xi_j} < 0 \tag{17}$$

Conclusion 2: Optimal income distribution rate of participant i in the project construction is proportional to his own input and the unit repurchase cost of input is inversely proportional to other participants' inputs and the unit repurchase cost of those inputs.

2.3 Influence of Risk Preference to the Income Distribution

In the analysis of last section, we assume that participants in the project construction are risk neutral. In the next section, we relax the assumptions of the model in order to enhance applicability of model. It assumes that the member i of alliance is expected to total income of the project scope is $[r_i^1, r_i^2]$. So member i would expect his own range of income is $[p_i r_i^1, p_i r_i^2]$. If the final total revenue of project construction is $R(N) = r$, in real situations, the revenue that member i actually received is $p_i r$. In this article, the absolute overestimate risk (AOR) and the relative overestimate risk (ROR) is that:

$$\mathrm{AOR}(i) = p_i r_i^2 - p_i r, \quad \mathrm{ROR}(i) = \frac{r_i^2 - r}{r_i^2 - r_i^1} \tag{18}$$

In the same way, defined the absolute underestimate risk (AUR) and the relative underestimate risk (RUR) is that

$$\mathrm{AUR}(i) = p_i r - p_i r_i^1, \quad \mathrm{RUR}(i) = \frac{r - r_i^1}{r_i^2 - r_i^1} \tag{19}$$

When the anticipated income are given, its relative overestimate risk should be small as possible and the bigger the relatively underestimate risk, the better. It means that the revenue of members will be more optimistic. At the same time, to measure the risk preference of different members in the alliance, we define the degree of risk of member i is $\mathrm{Ra}(i)$:

$$\mathrm{Ra}(i) = \frac{\mathrm{AOR}(i) - \mathrm{AUR}(i)}{\mathrm{AOR}(i) + \mathrm{AUR}(i)} \tag{20}$$

Clearly, $\mathrm{Ra}(i) \in [-1, 1]$. If $\mathrm{Ra}(i) = 0$, by definition, member i should be risk neutral.If $\mathrm{Ra}(i) \in (0, 1]$, member i should be risk preference. If $\mathrm{Ra}(i) \in [-1, 0)$, member i should be risk averse. If member didn't join the alliance, discount factor of the change of the utility is δ. The discount factor of member i is defined that:

$$\delta_i = \frac{u_i\left(y_i'\right)}{u_i\left(y_i\right)} \tag{21}$$

In (21), $u_i(x)$ is utility function of member i. In addition, setting the function $h(x)$, and :

$$h(x) = \frac{u(x)}{x} \tag{22}$$

If member i should be risk averse, $u''(x) < 0$. In this case, if $x > 0$, $xu'(x) - u(x) < u'(0) - u(0) = 0$. Thus, it can be proved that:

$$h\left(\pi\right) = \frac{u(y)}{y} < h\left(\pi'\right) = \frac{u\left(y'\right)}{y'} \tag{23}$$

That is, we can draw the conclusion that:

$$\frac{u\left(y'\right)}{u(y)} < \frac{y'}{y} \tag{24}$$

According to (24), the discount factors of the risk averse members are smaller than the discount factors of the risk neutral members. The more the risk averse of members, the lower bargaining power and the less share of extraneous income they can reap. On the other hand, they can reap the more share of extraneous income. To sum up, the discount factor can be expressed as:

$$\delta_i = g\left[\mathrm{Ra}(i)\right] \tag{25}$$

In (25), $g(x)$ is a strictly monotone increasing function with respect to x. It is said that the size of the discount factor of participants is proportional to the degree of risk preferences. When we consider influence of discount factor on bargaining power, (10) can be revised to the following form:

$$t_i = b'\delta_i\xi_i, \quad \sum_{i=1}^{2} t_i = 1 \tag{26}$$

Similarly, (13) can also be revised to the following form:

$$\alpha_i = \frac{\sum_{j=1}^{n\backslash i}\delta_j\xi_j - (n-2)\,\delta_i\xi_i}{\sum_{j=1}^{n}\delta_j\xi_j} + \frac{(n-1)\,\delta_i\xi_i\sum_{j=1}^{n}\xi_j x_j - \sum_{j=1}^{n}\delta_j\xi_j\sum_{j=1}^{n\backslash i}\xi_j x_j}{\pi\sum_{j=1}^{n}\delta_j\xi_j} \tag{27}$$

Using (27), we can know that:

$$\frac{\partial \alpha_i}{\partial \delta_i} > 0, \quad \frac{\partial \alpha_i}{\partial \delta_j} < 0 \quad i \neq j \tag{28}$$

Conclusion 3: Optimal income distribution rate of participant i in the project construction is proportional to his own risk preference, is inversely proportional to risk preference of other participants.

3 Conclusion

The results reported here show that the impact of the bargaining power and risk preference of participants on income distribution in large infrastructure projects, in which the distribution relates to whether the cooperation of projects succeeds or not. It finds that greater repurchase cost, leading to greater bargaining power, and more risk preference is associated with significantly higher share of extraneous income. A flexible and reliable income distribution mechanism is absolutely necessary to any comparatively perfect system of large infrastructure projects based on PPP mode, which the mechanism must be given the proper weight to the importance of cost, resource scarcity and risk through the above conclusion. To give a greater return for the members who provides scarce factors or takes greater risks. In developing countries, such as China, enterprises are needed to provide more financial and technical for construction of public facilities, which can be treated as scarce factors. So the return of enterprises generally should be larger than that of the government. It should be clear in the performance of the contract. Moreover, anti-risk capability determines the share of income distribution in the PPP cooperation. Strength enterprises will undoubtedly have a stronger ability to resist risks, which will occupy the vantage point in later competition. Therefore, enterprise should constantly strengthen its own technology and strength, upgrade the scientific content of public project construction, reduce construction cost and maintain its scarcity in the factor market.

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Part IV
Engineering Management – Project Management

Study on Strategic Environmental Assessment of Highway Construction Based on Entropy–AHP

Yu He

Abstract Being an effective means to implementing sustainable development strategy, strategic environmental assessment (SEA) is an assessment process of implementing project environmental impact at strategic level. Highway construction can effectively stimulate regional economic growth, while can cause serious environmental problems, so it is necessary to measure highway construction sustainability through the strategic environmental assessment. Based on the system analysis of environmental pollution caused by freeway construction about land resources, water resources, ecological resources, atmospheric environment, and entropy–AHP strategic environmental assessment method was used. And the expert subjective opinion and objective ecological data were combined. Finally, this method was used to empirical study on Jiangsu four area highways. The result shows that the method can effectively reflect the ecological environmental impact of highway construction.

Keywords AHP • Entropy • Highway • Strategic environmental assessment

1 Introduction

Because of the differences of route selection and the characteristics of planning region, the highway planning and construction will damage the landform along-the-highway, occupy abundant land resource, aggravate water and soil loss and result in a series of ecological problems. However, traditional environmental impact assessment often looks at the development projects only and lacks strategic insight, thus presents great boundedness in the practice. Strategic Environmental Assessment (SEA) is the expanding of environmental impact assessment on strategic level

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and the process of systematic and comprehensive assessment to the environmental impact of government policy, planning, project and alternative solution. As the efficient method of implementing the strategy of sustainable development, the raise of SEA has been paid high attention by academic circles, governments and relevant international organizations. With the development of economy, China comes to the rapid developing period of highway construction. However, it deserves intensive research that how to apply SEA, avoid highway construction damage to ecological environment, and maintain sustainable development of economy, society and environment in construction process.

Research on highway eco-environmental impact began in the 1970s. In 1970, Doctor Hans Lorenz from Germany firstly put forward road design method, of which man and natural environment were closely related, and strived to make the designed highway get not only rapid, safe-driving and graceful line and favorable travel environment, but also measures to protect the landscape and wildlife (Bao et al. 2004). At the end of the twentieth century, highway eco-environment impact gradually expanded to the reach on ecoenvironment impact of landscape scale. Mans firstly researched the segmentation, interference and damage of highway network to the natural habitat and access gallery (Nilsson and Holger 2001). At the same time, Freeman and the others also indicate that since the road development is adding lager and larger scope of impact on natural environment, researches on the impact of highway on ecological environment have become an important leading-edge field (Forman and Gordron 1986).

With the environmental emphasis of the country, Chinese ecological problems caused by highway construction has aroused widespread attention of all social sectors and some scholars have also conducted some researches on highway ecological protection according to the concrete project condition. Cheng Shenggao, Yu Hongxia (2000), etc, have conducted eco-environmental impact assessment on Yi-Huang highway and raised relevant environmental protection suggestions. Qian et al. (2001) thought that the damage of vegetation, the decrease of animal population habitat, the change and wind erosion of soil physico-chemical properties, and the interference to the production and life of original people are the main aspects of eco-environment impact of Tu-Wu great highway construction and operation. Liu Shan, etc (2007), have analyzed the main factors of the eco-environment impact of Chang-Chang highway, etc, to the Dongting Lake wet land, which are urbanization effect, water conservancy effect and highway separation and approach effect. Kou and Bao (2006) have analyzed the characteristics of Chinese highway network planning and the indicator system of environmental impact assessment of foreign transportation planning, put forward the basic thinking, procedure and standard of the construction of indicator system of environmental impact assessment of Chinese highway network planning.

By analyzing the literature, one can find that there are certain researches on the strategic environment of highway at home and abroad, but the researches now is not mature and perfect. On one hand, they did not systematically analyze the impact of highway construction to the regional environment and ecology; on the other hand, the wide cover and many related factors of eco-environment assessment made it difficult to accurately estimate its impact degree, so the researches were mainly nature determination. However, the method of nature determination can only make descriptive assessment on the eco-environment impact of highway construction project, and cannot make relatively scientific analysis and assessment on the eco-environment impact of highway construction and provide favorable basis for the selection of highway route and location and decision of related departments. It is generally considered that entropy method can reflect the utility value of the entropy of indicator information, the indicator weight value given by which has higher reliability and relatively suits the research on the problem of sustainable development assessment (Lv 2012). In order to avoid the assessment subjectivity of subjective weight determination, this paper tries to quantitatively research the problem of highway strategic environmental assessment with the combinative method of entropy and analytical hierarchy process, hoping to provide certain reference for the sustainable development of Chinese transportation industry.

2 Impact Mechanism of Highway Construction to Regional Environment and Indicator System of Strategic Environmental Impact Assessment

2.1 Impact Mechanism of Highway Construction to the Environment

Highway construction project has the characteristics of excessive points, long route, wide cover of environmental impact and large span of influencing space-time scope, so the environmental impact of highway construction is relatively complex. The concrete impact mechanism is as shown in Fig. 1.

2.1.1 Impact on Land Resource

1. The occupation of fertile farmland. In view of the return of investment and actual requirement of construction, highway is often located in the areas of developed economy and high population density. Comparing with high mountains and lofty hills, these areas are of flat terrain and fertile soil. The construction of highway project will occupy chronically part of the cultivated and uncultivated land of the areas along-the-highway, such as paddy field, dry land, orchard, forest land, house site, etc. The original functions of occupied cultivated and uncultivated land will be changed chronically. In addition, because highway construction results in the land segmentation, many fragmentary lands are not used efficiently, which will also result in the decrease of land resource.
2. The easy formation of water and soil loss. With the disturbance of highway construction and transport operation, the structure of natural soil is damaged,

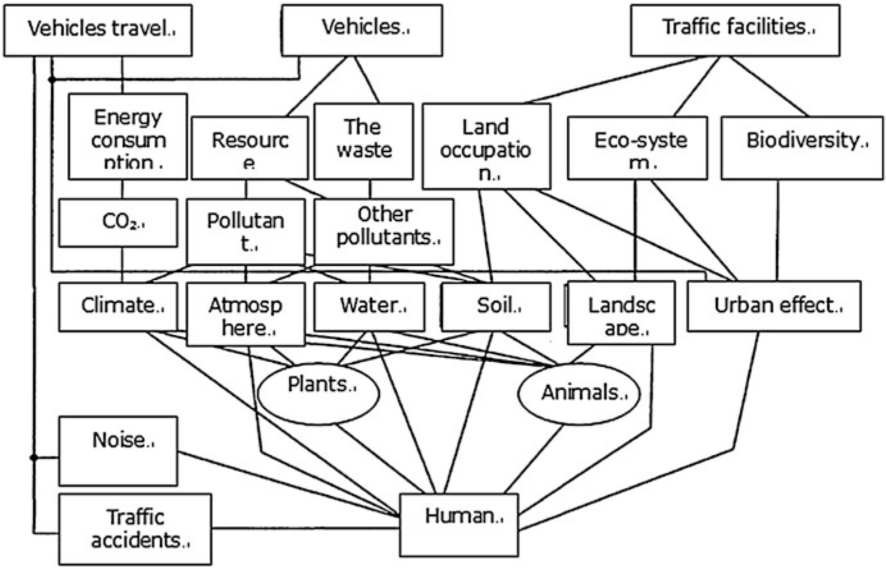

Fig. 1 Mechanism of environmental impact of highway construction

and its erosion resistance ability weakens greatly. Highway Research Institute of the United States has reported that if measures are not adopted in highway construction, a section of 1 km can scour nearly 25,000 t of soil (Hawley 1987). Water and soil loss caused by highway construction mainly focuses in the period of highway construction and early operation. When the natural environment changes because of the highway construction, the weak balance of local plant and water and soil is damaged, and the erosion begins. In addition, when the rainfall capacity is big, the abundant precipitous side slopes created in the process of filling and digging will form soil erosion.

3. The initiation of geological disasters. Many highway constructions will inevitably pass the mountain areas. Because of the landform restriction, there are forbidding sections of rush turns, precipitous slopes and narrow ways in most highways of the mountain areas, which needs slope excavation, embankment filling, tunnel excavation, etc. These activities are easy to cause geological disasters such as collapse, landslide, debris flow, etc, life and property loss of the masses, ecological damage, and serious water and soil loss. In addition, the abundant wastes produced in construction period may cause problems such as vegetation deterioration, water and soil loss, affected slope stability.

2.1.2 Impact on Living and Water Resources

1. Damaging the ecological balance. When highway crosses the ecosystem, it is like a barrier with the function of separation and obstruction, and divides the original

natural ecosystem into two. In addition, permanent land occupation of highway construction and temporary land occupations such as construction roads, mixing fields, camp buildings, etc, will damage the aboveground vegetation of areas along-the-highway. Because of the transportation of road materials, rolling compaction of the machines and trample of the constructors, a part of vegetation in the surrounding areas of construction work zones will be damaged. The earth-rock work of borrowing and abandoning will also damage the original aboveground vegetation.

2. Affecting biodiversity. Highway segmentation makes natural ecological environment segmented by island, and courtship and foraging scopes of living beings reduced. Living beings will become fragile, and may happen in transpacific differentiation after several generations. The wastes of mountain area highway which are poured into the valley make it difficult for animals to multiply, because their resting and breeding places are occupied by the wastes. The damage of ecological balance also makes living beings in the area die or move, which affects the biological resources in the area.
3. Causing unfavorable impact on water resource. Highway construction will change inherent situation of the overland runoff, thus result in local impacts such as washing, silting, water logging, soaking, etc. The highway separation function will make the changes of catchment basin of overland runoff happen, and change the directions of the runoff. The highway excavation section will result in water seepage on the sides of roadbed and excavated mountain slopes, if it locates under the prelatic line, and finally results in reduce of underground water level, withering of ground vegetation and increase of land derisiveness. In the filling section, the roadbed will increase the upper underground water level, reduce the tail water level and finally lead to similar results. In addition, in highway construction period, sanitary sewage of the construction team, oil abandonment of the construction machinery, construction materials like pitch, waste wash water of construction vehicles and material of construction, etc, will bring about great impact to the water quality of road surface runoffs, neighboring rivers, source of water, farmland, etc.

2.1.3 Unfavorable Impact on Atmospheric Environment

In highway construction period, impacts on atmosphere quality mainly concentrate upon the impacts of exhaust gas of construction machinery and dust of material of construction. For example, bituminous mixture amalgamator puts the dust of mine and fuel into the upper air, then the dust goes with wind, pollutes air and crops. The contaminated area and level of the dust are relatively high. In highway operation period, the main impact on atmospheric environment is the emissions of vehicles. 1–5 % of emissions of vehicles (different motorcycle types have different emissions) are pollutants produced in incomplete and complete combustions. Experimental researches at home and abroad have made it clear that emissions of motor vehicles which have direct harm to human health are CO (carbon monoxide), NO2 (nitrogen dioxide), HC (hydrocarbon) and the second ramification of emissions-photochemical smog, etc. It has been found in the monitors of different areas in China that in the above pollutants of ambient air, the emissions of vehicles hold higher partake rates. For example, the partake rate of CO is 65–80 %, the partake rate of NO2 is 50–60 %, and the partake rate of HC is 80–90 % (Xu 2006). In recent years, with Chinese vehicle holdings increase progressively at the annual rate of 15 %, the discharge of the above pollutants will also increase, and emissions of vehicles will be one of the main pollution sources of Chinese ambient air. There always form areas of pollutants of higher concentration and long-term duration in upper air of highway vicinities, which are harmful to human health to some extent. Meanwhile, they will also create serious impact on animals, plants, water and soil environment, and even result in global climatic anomaly.

2.1.4 Energy Consumption and Noise Pollution

The energy consumption of highway construction and operation mainly consists of three parts. Firstly, the energy power consumption in construction period, which mainly includes electricity and diesel. Secondly, the electricity consumption of service areas in operation period. Thirdly, the oil consumption of transportation vehicles in operation period. Experts estimate that in the highway construction period, the average electricity consumption is 200–240 MWh/km, and the average gasoline consumption is 130–170 t/km; in operation period, the average electricity consumption is 100 W/year/m^2, and the average lubricating oil consumption is 0.3 L/km per hundred cars (Wei et al. 2003). Thus it can be seen that highway construction will consume abundant energy and cause certain impact to eco-environment. In addition, noise pollutions of highway construction to the environment are mainly impact of noises of construction vehicles, construction machinery, etc on the surrounding environment in highway construction period, and impact of traffic noise on the highway sides in highway operation period Of which, construction noise is short-period impact, however, the impact of highway operation noise is long-period and more serious. With the soar of vehicle holdings, China has become the main power of motor vehicle production and consumption in the world. The concomitant is that noise pollution of motor vehicles has been more and more serious and become the second noise source of social life noises in the cities.

2.2 Indicator Construction of Highway Strategic Environmental Impact Assessment

Based on the above analysis process, construct indicator system of highway strategic environmental impact assessment. The concrete is as shown in Table 1.

Table 1 Indicator system of highway strategic environmental assessment

Sub-criterion layers	Indicator layers	Calculation remarks
Land resources B1	Rate of land occupation C11	Area of land occupation/gross area of the region
	Rate of water and soil loss (C12)	Area of water and soil loss/gross area of the region
	Damage extent of geological disaster C13	Geological disaster loss/regional GDP
Living beings and water resources B2	Damage rate of ecologically sensitive region C21	Area of damaged ecology/gross area of ecology
	Biodiversity C22	Generalities of living beings
	Water pollution degree C23	Total amount of water pollution/total amount of regional water resources
Atmospheric environment B3	CO Discharge C31	Product of annual motor vehicle amount and average discharge of each motor vehicle
	HC Discharge C32	Product of annual motor vehicle amount and average discharge of each motor vehicle
	NO2 Discharge (C33)	Product of annual motor vehicle amount and average discharge of each motor vehicle
Energy consumption and noise pollution B4	Electricity consumption C41	230 MWh/km*Highway Mileage
	Gasoline consumption C42	Product of annual motor vehicle amount and gasoline consumption of each motor vehicle
	Affected population C43	Resident population of 200 m around highway/total population of the region

Define abbreviations and acronyms the first time they are used in the text, even after they have already been defined in the abstract. Abbreviations such as IEEE, SI, MKS, CGS, ac, dc, and rms do not have to be defined. Abbreviations that incorporate periods should not have spaces: write “C.N.R.S.,” not “C. N. R. S.” Do not use abbreviations in the title unless they are unavoidable (for example, “IEEE” in the title of this article).

3 Construction Assessment Model

This paper assesses highway strategic environmental impact assessment by the combinative method of entropy and Analytical Hierarchy Process. Analytical method of entropy judges the dispersion degree of a certain indication by entropy. The bigger dispersion degree of the indication is, the greater the assessment impact of the indicator on the comprehensive assessment is. The biggest advantage of entropy weight is that the information toots in the original data of the selected assessment indicators, which is not affected by human factors. However, objective weight determination of entropy is lack of expertise knowledge, and the weight changes with the environment. Analytic Hierarchy Process (AHP) is a kind of convenient, flexible and practical multi-objective decision method of quantitative analysis of qualitative problems, which can qualitatively and quantitatively solve various problems which are relatively complex by the relative scores of experts on the problems Therefore, the combinative method of entropy and AHP can not only take full advantage of the judgment of expertise knowledge, but also conduct reasoning assessment on objective data, which has relative superiority and scientificity.

3.1 Data Standardization

Set that to conduct strategic environmental impact assessment on n highways construction, there are m assessment indicators, and x_i^j is the value of the jth indicator of the ith sample. To be convenient for calculation and optimization analysis and eliminate the difficulty of comparison caused by the difference of dimension, the standard formula can be applied to conduct standardized dispose on the assessment indicators. The dispose formula is as shown in (1):

$$r_{ij} = \frac{x_i^j - \min_i x_i^j}{\max_i x_i^j - \min_i x_i^j} \tag{1}$$

Formula (1) can translate the original matrix X_i^j into normalized matrix R_i^j, as is shown in Formula (2):

$$\left(R_i^j\right)_{n\times m} = \begin{pmatrix} r_{11} & r_{12}\cdots & r_{1m} \\ r_{21} & r_{22}\cdots & r_{2m} \\ a_{n1} & r_{m2}\cdots & a_{nm} \end{pmatrix} \tag{2}$$

Of which, $i = 1, 2, \ldots, n$, $\mathrm{j} = 1, 2, \ldots m$.

3.2 Calculating the Objective Weights of the Indicators by Entropy

First, calculate the weights of the indicators by the calculation rule of entropy.

$$p_i^j = \frac{r_i^j}{\sum_{i=1}^{n} r_i^j} \tag{3}$$

Therefore, the entropy of the jth indicator is:

$$e_j = -k\sum_{\mathrm{i}=1}^{n} p_{ij}\ \mathrm{lnp_{ij}} \tag{4}$$

Of which, $k > 0$ and $k = 1/In_n$, then the weight of the jth indicator in the assessment model is:

$$w_j = \frac{d_j}{\sum_{j=1}^{n} d_j} \tag{5}$$

Of which, $d_j = 1 - e_j$ is the diversity factor, then the vector of entropy weight is: $w = (w_1, w_2 \cdots w_m)^T$.

3.2.1 Calculating the Subjective Weights of the Indicators by Entropy

The impact degrees of highway construction on the environment are different. To determine the weight values and construct criterion layer and the positive and negative judgment matrixes of the four sub-criterion layers of land resources, living beings and water resource, atmospheric environment, resource consumption and noise pollution by 9-scale labeling method. And to calculate the weights by the method of eigenvector and conduct consistency checks on the weight results. If the weight results pass the check, the weight distribution is reasonable. Otherwise, the judgment matrixes should be reconstructed to calculate the weights. Write that the weight vector of criterion layer is: $\alpha = (\alpha_1,\alpha_2,\alpha_3,\alpha_4)^T$, and the weight vector of the ith sub-criterion layer is: $B_{i1}, B_{i2}, B_{i3}, B_{in},\ i = 1, 2, 3, 4$ then the compound weight of the B_{ij}th indicator to the destination layer can be indicated as: $\varepsilon_j = a_i \times b_{ij}$. Finally calculate the AHP weight vector is $\varepsilon = (\varepsilon_1,\varepsilon_2, \ldots,\varepsilon_m)^T$.

3.3 Combination Weight Determination and Final Assessment Result

According to Lin Zhengkui's opinions (Lin 2012), set η_j as the weight of the jth indicator of entropy-AHP combination, then:

$$\eta_j = \theta w_j + (1 - \theta)\,\varepsilon_j \tag{6}$$

Of which, θ is the rate of entropy weight to the combination weight, w_j is the entropy weight of the jth indicator calculated on the basis of objective data, $(1-\theta)$ is the rate of AHP weight to the combination weight, and ε_j is the AHP weight of the jth indicator calculated on the basis of expertise. Construct objective function with the minimum quadratic sum of the deviation of combination weight and entropy weight and the deviation of combination weight and AHP weight, as is shown below:

$$\min y = \sum_{j=1}^{m} \left[\left(\eta_j - w_j\right)^2 + \left(\eta_j - \varepsilon_j\right)^2 \right] \tag{7}$$

Calculate the first derivative of the above formula and make it 0, then $\theta = 0.5$. Which means that final combination weight is $\eta_j = 0.5w_j + 0.5\varepsilon_j$, indicating that in combination weight, the subjective and objective have the same cognition of importance degree of the indicators. In this way, the objective data and expertise can be combined organically.

Then the final result of the ith highway strategic environmental assessment is:

$$D_i = \sum_{j=1}^{m} R_i^j \times \eta_j^T \tag{8}$$

4 Empirical Analysis

Analyze highway strategic environmental assessment with the example of the four national highways in Jiangsu (Jiangsu section of Jing-Hu highway, Jiangsu-section of Hu-Ning highway, Yang-Li highway, and Jiangsu section of Ning-Hang highway) in 2001. To make it convenient, they are called highway A, B, C and D. All the data roots in Jiangsu Statistical Yearbook, Chinese Transport Statistical Yearbook and the feasibility reports of the four highways.

According to the procedure of the above assessment model, standardize the original data firstly and get normalized data matrix. Then, according to the formula, get the entropy vector:

$$w = \left(0.0861, 0.0821, 0.0812, 0.0807, 0.0718, 0.0925, 0.0902, 0.0819,\right.$$
$$\left.0.0902, 0.0913, 0.0617, 0.0903\right)^T$$

Secondly, invite experts on the environmental protection of highway construction to conduct strategic environmental assessment and get positive and negative judgment matrixes, which are respectively:

$$\begin{pmatrix} 1 & 1/3 & 3 & 4 \\ 3 & 1 & 4 & 5 \\ 1/3 & 1/4 & 1 & 3 \\ 1/4 & 1/5 & 1/3 & 1 \end{pmatrix} \quad \begin{pmatrix} 1 & 3 & 1/3 \\ 1/3 & 1 & 1/4 \\ 3 & 4 & 1 \end{pmatrix} \quad \begin{pmatrix} 1 & 2 & 1/3 \\ 1/2 & 1 & 1/3 \\ 3 & 3 & 1 \end{pmatrix}$$

$$\begin{pmatrix} 1 & 3 & 2 \\ 1/3 & 1 & 1/2 \\ 1/2 & 2 & 1 \end{pmatrix} \quad \begin{pmatrix} 1 & 3 & 1/3 \\ 1/3 & 1 & 1/4 \\ 3 & 4 & 1 \end{pmatrix}$$

According to the above calculation procedure of AHP, one can get that the weight vector of criterion layer is $(0.2687, 0.5287, 0.1343, 0.0683)^{\mathrm{T}}$. The weight vector of sub- criterion layer of land resources is $(0.6483,0.2297,0.1220)^{\mathrm{T}}$, the weight vector of sub- criterion layer of ecological resources is $(0.2493,0.1571,0.5936)^{\mathrm{T}}$, the weight vector of sub- criterion layer of atmospheric environment is $(0.5396,0.1634,0.2970)^{\mathrm{T}}$, and the weight vector of sub- criterion layer of resource consumption and noise pollution is $(0.2684,0.1172,0.6144)^{\mathrm{T}}$. The consistency coefficients of relevant judgment matrixes are respectively 0.0677, 0.0036, 0.0516, 0.0088, 0.0707, which have passed the check Therefore, one can calculate AHP weight vector according to the formula:

$$\varepsilon = \left(0.1742, 0.0617, 0.0327, 0.1318, 0.0831, 0.3138, 0.0725, 0.0219,\right.$$
$$\left.0.0399, 0.0369, 0.0112, 0.0203\right)^T$$

According to the formula, calculate the weight vector which is based on entropy-AHP:

$$\eta = \left(0.1301, 0.0719, 0.0570, 0.1063, 0.0774, 0.2032, 0.0813, 0.0519,\right.$$
$$\left.0.0650, 0.0641, 0.0364, 0.0553\right)^T$$

Conduct environmental assessments of the four highways according to the formula and combination weight formula. The result is as shown in Table 2:

It is known from Table 2 that the score of Strategic Environmental Assessment of Highway B (Jiangsu-section of Hu-Ning highway) is 0.559, which is the minimum, meaning the minimum disruption of the whole environment. However, Highway D (Jiangsu-section of Ning-Hang highway) has got the maximum score and has the maximum environmental disruption In fact, in the concrete highway construction process, Hu-Ning highway construction process has adopted powerful measures of

Table 2 Highway strategic environmental assessment

Indicators	Highway A	Highway B	Highway C	Highway D
C11	0.092	0.080	0.081	0.095
C12	0.038	0.023	0.047	0.042
C13	0.025	0.018	0.037	0.036
C21	0.058	0.045	0.057	0.076
C22	0.049	0.032	0.050	0.046
C23	0.110	0.131	0.138	0.167
C31	0.053	0.054	0.044	0.048
C32	0.038	0.040	0.034	0.034
C_{33}	0.042	0.049	0.039	0.041
C_{41}	0.034	0.038	0.035	0.033
C_{42}	0.021	0.023	0.023	0.021
C_{43}	0.034	0.027	0.031	0.030
Aggregate scores	0.594	0.559	0.615	0.669

environmental protection to save land and prevent noise and water pollution, and has achieved obvious effects in preventing the reduction of environmental quality. For example, reduce land occupation by borrowing earth concentratively and renovating borrow pits into fishponds, and use coal ash to construct roads with the cooperation of the electric power department. Hu-Ning highway construction and operation have caused certain impact to the wetland nature reserve of Yangcheng Lake. However, the environmental adaptability of wetland living things are stronger and there is no large beasts, so the disappearance and serious reduction caused by highway construction and operation did not appear. In addition, the drainage system of Hu-Ning highway has adopted comprehensive drainage system. The design has followed the principles of pond-road separation and road-field separation, and made the highway drainage system establish its own system. Finally the water has drained into the rivers, drainage channel and borrows pits of the original river system. Atmospheric environmental monitoring along Hu-Ning highway has shown that $CO < 4{,}100\ mg/Nm^3$, which is superior to the secondary standard of atmosphere quality.

5 Conclusion

With strategic environmental assessment, highway construction can pay attention to environmental problems at decision phase of highway network, reduce unfavorable environmental impact caused by decision failure of highway network planning, organically combine abstract and macroscopical requirements of sustainable development strategy with concrete highway construction project, and promote the scientific development of transportation industry. According to the theory of strategic environmental assessment, this paper analyzes the impact mechanism of highway construction to the regional environment, and upon which, put forward the concrete indicators of strategic environmental assessment. This paper also researches on the combination of subjective opinions of experts and objective data by the combinative method of entropy construction and AHP. The empirical researches on the four regional highways in Jiangsu show that this method can reach better effect, thus provide a new thinking for highway strategic environmental assessment.

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A Study into the Implementation Path of the Whole Process Cost Consultation Business: A Perspective of Integrated Consultation

Jiao-jiao An and Jin-qin Yan

Abstract For the problems in traditional cost consultation business, such as stages being divided, information flow being obstructed, and so on, this paper studies the whole process cost consultation business and finds that it is different from traditional cost consultation business in integration. The whole process cost consultation business involves lots of information and specialized knowledge. Therefore, to ensure the smooth implementation of whole process cost consultation, we must realize the integration of information and specialized knowledge and introduce modern integrated consultation tool—full life circle cost management theory and value management theory, to guarantee the integration of cost consultation business. Through analyzing the whole process cost consultation business of a benchmarking enterprise—Davis Langdon & Seah (DLS) Construction Consultants Co., Ltd., to probe into the scientificalness of validation research.

Keywords Integrated consultation tool • Integrated consultation • Information management system • Matrix organizational structure • The whole process cost consultation

1 Introduction

Engineering cost consultation is a product of consultation and the segmentation and specialization of project consultation. Engineering cost consultation is gradually integrating with the world market, in consultation theory and tools in China after nearly 30 years rapid development. However, there are some problems such as a narrow range of business, employees' low quality and simple organizational structure, and so on in traditional Chinese cost consultation business (Shi-bo Dong

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2006; Yong-fa Song et al. 2007; Feng Xing 2009). And the whole process cost consultation business can make up for those shortcomings very well.

Compared to the traditional engineering cost consulting business, the whole process cost consultation business has the characteristic of integrated consultation. That is, consulting companies regard each stage of consulting work as an organic whole to seek optimal consulting results. The requirements of integration run through the whole process cost consultation business. The whole process cost consultation business is a dynamic and integrated cost management process in the perspective of integrated consultation (Tao Liu et al. 2005). So it can solve some problems brought about by traditional engineering cost consultation business in units and stages division (Ping Zhang and Yi-lin Yin 2003).

The existing research about integrating management focuses on construction management of various projects, such as road projects, water transportation projects, military construction projects, electrical engineering projects and so on. Guo-zong Zhang, Wei Li considered that the realization of integrating management should be based on network organizational structure and integrating management software system in the life cycle of project (Guo-zong Zhang 2009; Wei Li and Xiao-qun Liu 2004). Yi-gong Zhang and Yong-qiang Chen believed that information integration was the basis of integrated management (Yi-gong Zhang and Xing Gao 2010; Yong-qiang Chen and Lin Jiang 2009). Lu-yuan Fan studies the application of matrix organizational structure in the integration projects of information system (Lu-yuan Fan and Xiong-bao Dong 2011). Obviously, scholars' views are consistent with the implementation path of project's integrating management and approve that information integration and organization integration are indispensable to the integrated management of projects.

Although most scholars accept that the whole process cost consultation has the characteristic of integrated consultation, as a kind of consultation service project, it must realize the requirements of whole cost consultation business for integrated consultation, while the major challenges and solutions of the whole process cost consultation business development are rarely discussed, which is exactly what this paper needs to solve. Therefore, this paper studies the development path of the whole process cost consultation business aimed at the problems existed in traditional cost consultation business from the integrating feature of the whole process cost consultation business. At last, the paper provides reference for the development of domestic business through the study of whole process cost consultation business of Davis Langdon & Seah.

2 The Necessity of Integrative Consultation

2.1 The Characteristics of Traditional Cost Consultation Business

Since the traditional cost consultation business scope was narrow, the tasks (such as budget estimates, budget or final settlement) were simply assigned to different functional departments after consulting companies accepted the business. The functional departments used their professional skills to accomplish the department task, and consulting company transferred the integrated results to clients after functional departments completed the their tasks using professional skills. The consulting business was successfully completed.

The shortcomings of traditional consulting business are listed as follows. The work is separated,; functional departments lack communication; consulting work lacks integration which results in information asymmetry between two stages; coordination difficulties between previous and next stages increases transaction costs; meanwhile, the project resources are wasted, especially “three-excesses”(excessive estimate, excessive budget and excessive settlement). The costs of project are out of control.

2.2 The Characteristics of the Whole Process Cost Consultation Business

According to the whole process cost consultation regulations (CECA/GC4-2009), the whole process cost consultation business can be regarded as a project. Consulting companies can use project management concept to develop business. In accordance with the procedures of project development, the whole process cost consultation can be divided into three stages: project preparation, implementation and ending. During the project preparation stage, consulting companies turn consultation business information that the clients need into project objectives. Then, in the implementation phase of project, consulting companies work on cost defining and controlling in all phases, including decision-making, design, trade, construction and completion, using the whole process cost management theory and technology to ensure the later costs are not more than the previous, and finally output the implementation results. The specific process is shown in Fig. 1. As can be seen from this process, the phased results and final deliverables of the consultation are directly formed in the implementation phase of the whole process cost consultation business. The implementation phase is a critical stage whether consulting results can meet or even exceed clients’ needs.

As shown in Fig. 1, the main feature of the whole process cost consultation business is to integrate the works of all stages. It is not a simple list of each control point and consulting work of all construction stages, but regards each stage consulting work as an organic whole. When the decision guides design, design guides trade, trade guides construction and construction guides completion, strive to make the information in later stage to integrate in the early stage to optimize consulting results by making the work of the previous stage not only guide but also consider the cost of the next stage. This is exactly the connotation of the whole process construction cost consultation.

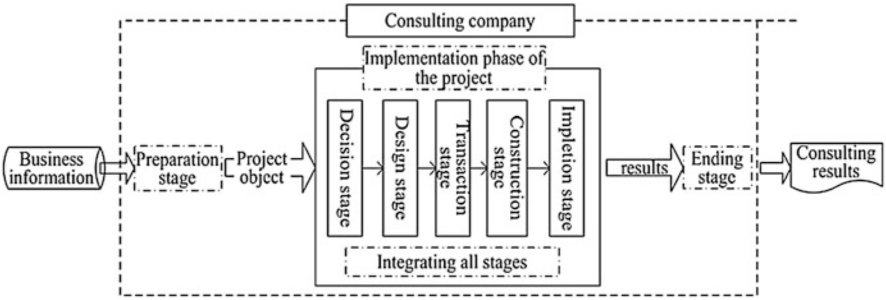

Fig. 1 Process of the whole process cost consultation business

Through an analysis into the traditional cost consultation business as well as the implementation of whole process cost consultation business, as a kind of integrated consulting, to make up for the poor information circulation and imperfect organizational structure in traditional business, whole process cost consultation business should realize the integration of information and specialized knowledge and introduce modern integrated consultation tools.

3 Implementation Path of the Whole Process Cost Consultation Business: Realization of Integrated Consultation

3.1 Establish Information Management System—To Realize Information Integration

The whole process cost consultation business should establish information management system to overcome the problem of work division and poor information circulation in traditional cost consultation business and use it as a platform for the exchange and share of information and the clarification of stakeholders' demand.

Information sources of information management system include two levels—outside and inside the project. The external information comes mainly from project stakeholders, price information and the historical data and internal information comes from each completed phase. It is shown in Fig. 2.

The needs of owners (clients) and other shareholders of project entered in system can make sure that the consultants in every stage can get most original needs information, avoid the distortion of required information transferred in turn in all stages, which causes the consulting results unable to meet client needs. Secondly, the later stage can get cost consultation guidance and information from preceding stage easily and exactly, as guidance for the cost consultation at later stage. Finally, all personnel in the project use information management system to exchange

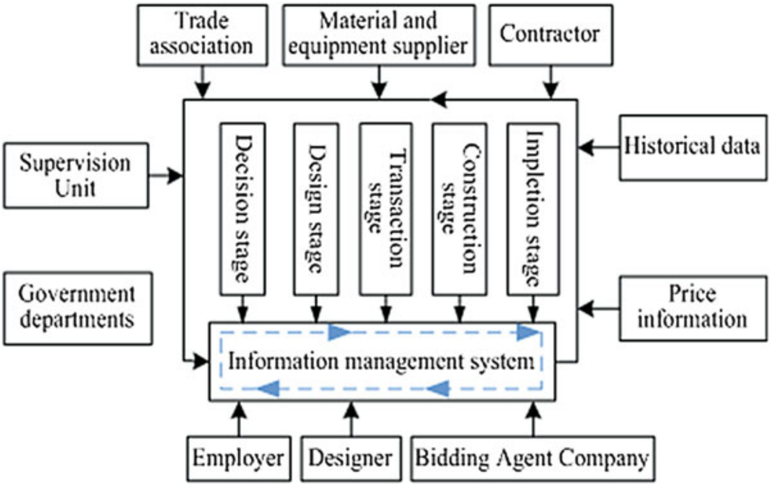

Fig. 2 Information sources of information management system

information and communicate with each other. It can make the information at later stage better reflected to the previous stages, to realize the anti-displacement of information.

3.2 Set Up Matrix Organizational Structure—To Realize Professional Knowledge Integration

Functional organizational structure is used in most traditional cost consulting companies. This organizational structure is generally suitable for small or single projects, strong specialty, without involving in many sectors and adaptable to traditional cost consultation business (narrow business scope and simple business). However, with the consultation business transformed to "the whole and the full", linear functional organizational structure has been unable to adapt to the changes brought about by the expansion of the scope and scale of business. In this situation, consulting companies adopt matrix organizational structure. The advantage of this structure is that consulting activities begin to focus on owners' trust and is reflected in the developing of the whole process cost consultation business.

Under such a structure, professionals at all stages of the project can fully communicate. So the professionals of later stage can influence consulting work in early stage by their professional knowledge and at the same time, professionals of the early stage can easily guide the consulting work of later stage.

All in all, the matrix organizational structure ensures no interval exchange among personnel at all stages, which realize the knowledge sharing in different stages. It meets the knowledge needs of integrated consulting.

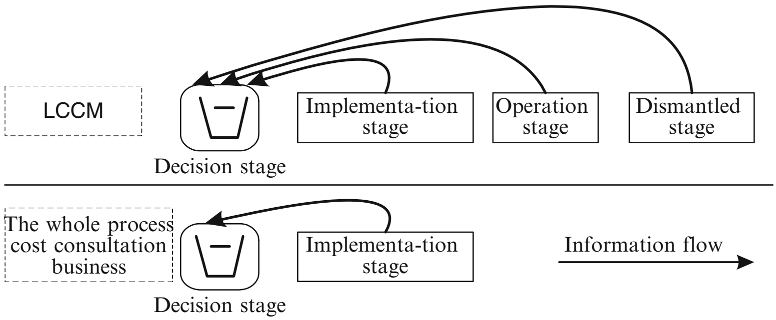

Fig. 3 Information integration of LCCM

3.3 Use Modern Integrating Methods—To Realize Consulting Scheme Integration

1. Integrated Consultation Tool 1: life cycle cost management. The core idea of Life Cycle Cost Management (LCCM) is to consider the LCC of a project as subject and strive to minimize the costs through design and plan, The whole process cost consultation only aims are the construction process, while LCCM also takes the operation process and its discard and dismantlement into consideration. Therefore, the idea of LCCM has very good supplement for the whole process cost consultation.

LCCM enriches the method for whole process cost consultation information for forward integration. LCC includes the costs of design-making, design, trade, construction, completion, operation as well as the dismantlement of whole project in life cycle. Therefore, the use of LCCM idea can not only realize the anti-displacement of information in implementation, but also the anti-displacement of information in operation and dismantlement. As shown in Fig. 3. LCCM is mainly used as an idea to guide the decision and design in the whole process cost management. When applied to the whole process cost consultation, it can make the consulting work more penetrative in decision-making stage of cost consultation.

2. Integrated Consultation Tool 2: value management. Value management is a systematic method, with the whole project as research object, functional analysis as orientation, group decision as foundation and value maximizing as target. It can enhance the value and benefits of the whole project.

Value management realizes the professional knowledge integration in the implementation of whole process cost consultation business. In consultation business, the specific application method is to set up value management activity groups composed of professional cost engineers, owner representatives, architects, structural engineers and related staff, taking on the form of centralized conference and using methods such as brainstorm, to share professional knowledge in every subject, reduce the investment outlay of owners as purpose, to analyze the functions and costs of project, to reduce as many costs as possible, increase the functions of project, and finally achieve the goal of reducing the costs of projects.

4 Case Study—A Case of Davis Langdon & Seah

Davis Langdon & Seah is the world's leading quantity surveying (i.e. project cost) consulting group. It specifically provides professional consulting business for construction and engineering sectors. DLS mainly carries out quantity surveying and construction cost management business, which is the whole process cost consultation business in China. DLS as a benchmark enterprise in engineering consultation industry forms global business and resources through information sharing system and database, strong consultation tools, reasonable project organizational structure, and then develops the quantity surveying and project cost management business successfully.

The business in DLS obviously reflects the integration features of the whole process cost consultation business—to achieve information and professional knowledge integration through shared information management system, matrix organizational structure and strong consultation tools,

Because DLS (Singapore) is the first Asian company founder and also regarded as headquarter in Asia, the company scale, personnel quantity and business development are more mature. While taking into the characteristics of the Chinese mainland into account, DLS (Singapore) and DLS (Beijing) are mainly taken as examples for analysis below.

4.1 Realization of Information Integration—Shared Information Management System

The information management system of DLS (Singapore) is quite complete, which can be divided into two sections: knowledge management and information management.

1. Knowledge management. DLS (Singapore) establishes the knowledge management centre to achieve the sharing of technical tools and knowledge. Its main task is to meet the information needs of users through constant update of information. There are two main goals. The first is to collect and update information, and the second is to establish a comprehensive information collecting database.

DLS (Singapore) mainly uses the following channels to collect relevant information, such as Main Knowledge Information Management System (KIMS) collection, Dictionaries, Directories, Seminar Notes and so on. In addition to the Main

KIMS collection, the gathering of overseas information and related information and materials on management and other information can be used for the staff's reading and reference. Moreover, all items in the knowledge management system are uniclass based on books classification. If employees need a certain type of information mentioned above, users can retrieve all the information stored in the library using Alchemy Database.

2. Information management. Information management is an important guarantee for smooth development of business in DLS (Singapore), and it mainly relies on softwares to standardize business operational procedures. The common used softwares are MS office 2003 outlook/word/excel/power point, MS project, AtlesPro, Concep, CAD Measure and so on. These software can provide project information. Furthermore, DLS (Singapore) has the internal practice-oriented network system Dalasnet, which can facilitate the exchange, business operation and cooperation among users in the organization.

So, the perfect information management system of DLS (Singapore) can realize the information sharing and provide good service for the whole process cost consultation business.

4.2 Realization of Professional Knowledge Integration—Matrix Organizational Structure

The organizational structure of DLS (Beijing) is as shown in Fig. 4. It is composed of two branch offices, Tianjin and Beijing, two project departments in CCTV and Qingdao, ministry of finance, ministry of personnel and administrative department, etc. Head of the project department is responsible for the communication with customers and customer satisfaction surveys in production process. It is taken as a project operation, when the whole process cost consultation business is developed. Civil Engineering Department chief (namely Civil Engineering Department leader) in Civil Engineering Department assigns a qualified senior estimator as the person in charge of all works in the project—project estimator, who assumes all the work of project. Members of the project team come from Civil Engineering Department, Electric Department, Heating Ventilation and Air Conditioning Department. The arrangement of personnel is coordinated by the leader. The implementation of project is led by Civil Engineering Department, coordinated with Electrical Department, Heating Ventilation and Air Conditioning Department.

This kind of organizational structure is a typical matrix structure. The project department strives to fulfill the target of consultation projects in every stage. The development of work all centers on one core: to satisfy or even exceed the need of clients.

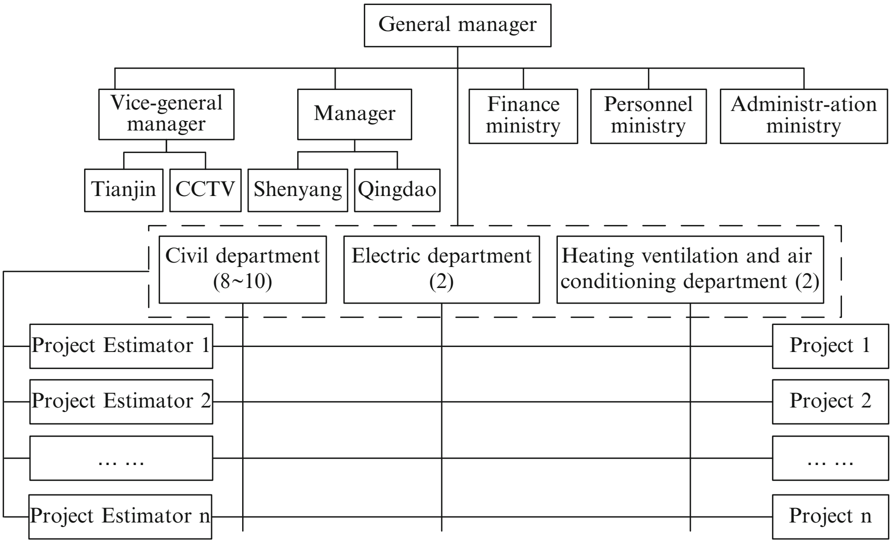

Fig. 4 Organizational structure of DLS (Beijing)

4.3 Realization of Consulting Scheme Integration—Strong Consultation Tools

DLS (Singapore) considers the whole life cycle of the project when developing the whole process cost consultation business, and adopts value management as a major integrating consultation tool. The usage of value management is as shown in Table 1.

Through the three paths above, DLS (Singapore) realizes the integration of information and professional knowledge in the whole process cost consultation business. (1) In information management, collect and update information in time, establish a comprehensive information database to meet the needs of consulting personnel, and fully realize information sharing. Also, the powerful software system and internal network system of DLS (Singapore) make the information sharing possible, and ensure the integration of quantity surveying and construction cost management business. (2) In organizational structure, matrix organizational structure of DLS (Beijing) guarantees the information exchange in early and later stage, avoids information distortion, realizing the knowledge integration in the whole process cost consultation business. (3) In consultation tools, apply the mature tool—value management, in the life cycle of the whole process cost consultation business. Consider the effect of each decision on the next phase of the project, from the very beginning of project, realize the integration of information and professional knowledge in every stage and achieve the overall goal.

Table 1 Application of value management

Phases	Phase names	Application of value management
1	Strategic assessment	To identify the needs, objectives and keys of stakeholders with value management
2	Program decisions	To evaluate possible schemes to satisfy customer needs, through value management analysis
3	Acquisition strategy	To develop output based standard, perfect and evaluate the programs to satisfy the comprehensive needs and targets of program, through value management
4	Investment decision	To formulate selection and reward criteria through value management
4.1	Overall design	To optimize the quality and costs of whole-life design through value engineering study, set up project teams to evaluate the feasibility of design.
4.2	Detailed design	To optimize the quality and costs of whole-life design through value engineering study, set up project teams to evaluate the feasibility of design.
5	Construction process	To use value engineering for the completion, etc. of project.
6	Benefits evaluation	To review the results of value management application and feedback the summary of experience

The whole process cost consultation business can effectively avoid the issues existed in traditional cost consultation business such as “three excesses” and horizontal information asymmetry. However, consulting companies should grasp the profound meaning of integration when developing the whole process cost consultation business. This paper puts forward that the whole process cost consultation business, as a kind of integrating consultation, needs to realize information and professional knowledge integration, and provides integrating path, such as constructing information management system, matrix organizational structure and the application of modern tools—life cycle cost management and value management, to realize the sequential flow of information and its integration towards previous stage. Finally, the paper analyzes the whole process cost consultation business in Davis Langdon & Seah from the perspective of integration, verifies the three paths of the whole process cost consultation business developing, and confirms the feasibility of this article. But the usage of the whole life cycle cost management and value management theory still needs further research.

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The VE Project Selection of Real Estate Program Based on ANP

Pan-jie Zhang, Ya-juan Han, and Guo-fang Song

Abstract This article is written from the point of value engineering application in the real estate program. By analyzing the connection between the function and the cost of the project, combining the specific circumstances of the case, it builds the evaluation model of the real estate value engineering program based on ANP. Finally, the evaluation of an empirical real estate project research is used on this evaluation system, which shows the effectiveness and feasibility of the model.

Keywords ANP • Project selection • Real estate program • VE

1 Introduction

In order to get the victory in a fierce price war, companies must meet the demands of users and optimize the design, reduce the design costs and improve economic efficiency. As features and costs of the product are determined in the design phase, it has become the key issues of how to scientifically and accurately identify the relationship between functionality and cost in the product design, and enhance the value of coefficient and choose the best design. In the process of value engineering (VE), the specific object needs the quantitative analysis. Varieties of quantitative methods are widely used in VE, such as: mandatory rating method, multi-scale score, etc. To some extent, it is able to quantify things scientific by these methods, but there are also some drawbacks.

Analytic Hierarchy Process, namely AHP (The Analytic Hierarchy Process), is a practical method for multi-objective decision-making. It can deal with a separate internal hierarchical structure. The core idea of the AHP method is that the system is

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divided into levels. We only consider the domination and the influence of the upper elements to the next level elements, neglecting the counterproductive effect. It is also assumed that the same level elements are independent of each other, and there is no interdependence (Saaty 1980). With regard to the network structure with the internal dependencies, Professor T.L. Saaty proposed a scientific decision-making method for such a complex structure - analytic network process, namely ANP (The Analytic Network Process) (Satty 1996). It is a new practical decision-making method developed based on AHP. Compared with the AHP method, the hierarchical structure of ANP has greater flexibility. When dealing with the evaluation issues, ANP method takes the interdependence between the elements, as well as between the set of elements into account (Edwards and Shaoul 2003).

ANP is a nonlinear structure, the essence of which is regarding a certain element as a criterion to rank the importance of the other elements to it and find its limit state, and that is the limiting relative ranking. Due to its combination of quantitative and qualitative analysis methods, it is suitable for solving the quantification and evaluation issues in VE, such as object selection, function evaluation, project selection, etc. When it is applied to the VE issues, it can make up for the defects of the original numbers of quantitative methods, and it can solve some quantitative problem, and enrich and perfect the quantitative methods in the VE. Take the real estate project of this article as an example, ANP network structure model can preferably reflect the complex staggered relationship between the functions and costs of the real estate projects, and it can help to select the project of the real estate in the design stage more effectively.

2 Value Engineering

Value Engineering has developed into a mature modern management technique, which is very effective in enterprise management. Using value engineering in the construction projects is an effective way to conserve resources, improve effectiveness, and reduce costs (Qing-hui Li 2013). Controlling the project cost at the design stage reflects the idea of a "pre-control". The improvement and promotion of value engineering theory to choose the best project can effectively control the project cost in practical projects. The expenses of the design phase of is less than 3 % as a percentage of the entire project, but the degree of the influence of the project cost may be more than 75 %. Obviously, the design phase of cost control is the focus of the project cost control.

Value engineering reflects the relationship between the study product features and cost. Thereby improving the function of the product or reducing costs can both enhance the economic benefits. In selecting the multi-project by value engineering, it's available to make decisions by the comprehensive evaluation of the performance of projects through the value coefficient, which is calculated as follows:

$$V = \frac{F}{C}$$

(Where: V is the value of the coefficient; F function coefficients; C cost factor.)

3 The VE Evaluation Method Based on ANP

Value engineering project evaluation is a typical multi-objective decision-making problem. Like other traditional comprehensive evaluation methods, it ignored the interaction between the indicators when determining the index weight, which is clear that there are many shortcomings. In order to solve such multi-attribute decision making problem, Thomas L. Saaty et al. proposed the ANP methods afterward (Shi Shanchong and Wang Zhiying 2006; Tang Xiaoli and Feng Junwen 2006). This article intends to adopt the ANP method to select the options. Combining Analytic network process steps and value engineering model can construct the value engineering program evaluation methods based on the ANP. The detail procedures are as follows:

3.1 Selecting the Critical Evaluating Index

Value engineering is to assess the pros and cons of the projects. The final standard is the value of the project, namely the ratio of the function and cost. The highest value of the project is the preferred solution. In accordance with the characteristics of real estate projects and the survey data, select the chief indicators and secondary indicators. The chief indicators are: function, cost. The secondary indicators include the applicable performance, security performance, visual effects, the land cost, pre-development costs, construction engineering costs, infrastructure and public facilities costs, temporary costs, unforeseen costs, etc.

3.2 Constructing the Evaluating Network Structure

According to the principle of ANP, combined with the connotation of the indicators and their relationship, we can build the ANP model shown in Fig. 1. Generally, we assume that the control level of ANP includes the following elements: $P_1, \ldots, P_n$. Under the control layer, the network layer contains the elements $C_1, \ldots, C_n$, and each element C_i has its elements: $c_{i1}, \ldots, c_{ini}(i = 1, \ldots, N)$. Taking the control layer element P_s $(s = 1, \ldots, n)$ as a criterion and the element $c_{jl}(j = 1, \ldots, n_j)$ in C_j as a sub-criteria. Comparing the elements in set C_I according to the influence degree to the c_{jl} and constructs the judgment matrix (Guo De and Liang Juanhong 2008).

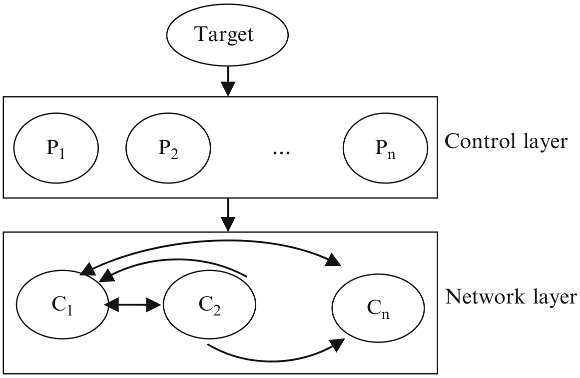

Fig. 1 The analytic network process model

Table 1 Judgment matrix scale

Intensity of importance	Explanation
1	Two activities contribute equally to the objective
3	Experience and judgment slightly favor one activity over another
5	Experience and judgment strongly favor one activity over another
7	An activity is favored very strongly over another; its dominance demonstrated in practice
9	The evidence favoring one activity over another is of the highest possible order of affirmation
2,4,6,8	Representing an intermediate value of the adjacent
Reciprocal: If the ratio of the importance of the element i and element j is a_{ij}, the ratio of the importance of the element i and element j is $a_{ji} = 1/a_{ij}$	

3.3 Getting the Judgment Matrices and the Sorted Vector of the Elements in the Control Layer

Comparison matrix is the comparing among the lower indicators in aspect of the relative importance to the indicators on the upper, or the matrix of effectiveness of the project layer to the certain indicator. In order to quantify each pair wise comparison matrix, Satty gave the following scale. The ANP model uses this Satty scale as well, as is shown in Table 1:

Compare and analyze the elements in the set C in the network layer according to their influence to c, and construct the judgment matrix under the element $P_s(s = 1,2,\ldots,m)$ of the control layer. We can get the ordering vectors $(w_{i1}^{(jl)}, w_{i2}^{(jl)}, \ldots w_{inj}^{(jl)})^T$ by the characteristic roots, which is:

$$W_{ij} = \begin{bmatrix} w_{i1}^{(j1)} & w_{i1}^{(j2)} & \ldots & w_{i1}^{(jn_j)} \\ w_{i2}^{(j1)} & w_{i2}^{(j2)} & \ldots & w_{i2}^{(jn_j)} \\ \ldots & \ldots & \ldots & \ldots \\ w_{in_j}^{(j1)} & w_{in_j}^{(j2)} & \ldots & w_{in_j}^{(jn_j)} \end{bmatrix}$$

Column vectors of matrix W_{ij} is the ordering vectors of the elements in C_i in aspect of the importance to the elements in C_j.

3.4 Construction and Calculates the Ultra-Matrix and Limit Super Matrix

If the weight of the criteria and the elements in the control layer or the network layer are irrelevant, it can be got through AHP. Otherwise, we should get the super matrix $W = (w_{ij})_{N\times N}$ under the criteria of P_s by combining their sorted vectors. Then compare the importance of each element to the certain element set $c_j(j = 1,2,\ldots,N)$ under the criteria of P_s, and get the normalized eigenvector$(a_{1j},a_{2j},\ldots,a_{Nj})^T$. Do the power operation on the super matrix W for $2k+1$ times, namely $W(k) = W^{2k+1}(k),(k = 1,2\ldots,N)$, until it meets the convergence conditions: $W(k) = W(k + 1)$. In the super matrix $W = (w_{ij})_{N\times N}(i,j = 1,2,\ldots N)$, the sum of each column vector is 1(Wang Lianfen 2001).

3.5 Calculating the Comprehensive Evaluation Value of Each Alternative

In the process of scoring on each project under the criteria of varies of factors, the importance and the satisfaction degree of the indexes are gained through grading by the users, designers, constructors, expert, etc. The final satisfaction degree is get by the weighted importance of every index: $D = \sum A_i W_i$, in which: W_i is the long-term weight of the ith evaluating indicator in the super-matrix. A_i is the relative importance of each project to the sub- criteria i (Shi and Wang 2005). According to the formula, multiply the value of each evaluating indicator by weight of the corresponding indicator in the network layer, and sum up the results as the final evaluating value.

4 Empirical Research

This paper takes a real estate project for an example. A construction project has a total land area of 76.94 acres. The total investment is expected to be 250 million. According to the land price and the plot ratio requirements, the multi-storey residence is no greater than 1.2; the high-rise is in the range of 2.0–2.2. Three development projects of which are available for reference:

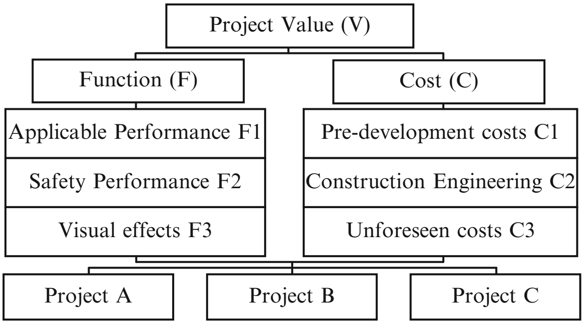

Fig. 2 VE program evaluation model of ANP

1. Project 1: The bundle development contains 70 % of the multi-storey and 30 % of the high-rise (The plot ratio is 1.2 and 2.2 respectively). The sales price is 2,800 yuan/m^2 and 3,600 yuan/m^2 each.
2. Project 2: The bundle development contains 40 % of the multi-storey and 60 % of the high-rise (The plot ratio is 1.2 and 2.2 respectively). The sales price is 2,900 yuan/m^2 and 3,600 yuan/m^2 each.
3. Project 3: The bundle development contains 40 % of the multi-storey and 60 % of the high-rise (The plot ratio is 1.2 and 2.0 respectively). The sales price is 2,900 yuan/m^2 and 3,700 yuan/m^2 each (You 2010).

4.1 Selecting the Critical Evaluating Index

Select the value of the project and the function and the cost of the project as the indexes of the control layer of the model. In the network layer, considering the diversity of the elements and the data, the function set contains three indexes: Applicable Performance, Safety Performance and Visual effects; the cost set contains three indexes: Pre-development cost, Construction Engineering fees and unforeseen costs.

4.2 Constructing the Evaluating Network Structure

Constructing the ANP model of the VE project evaluation as Fig. 2 according to the index selected.

According to Fig. 2, in this model, the control layer only includes the total value of the target program, without the evaluation criteria. Thus, the maximizing the project value is both the purpose of the evaluation and the criteria. All the elements are compared directly under the criteria of maximizing the project value.

Table 2 Comparison matrix of function and cost

	Function (F)	Cost (C)	Relative weight
Function (F)	1	3	0.75
Cost (C)	1/3	1	0.25

Table 3 The comparison matrix of the elements within the cost set under the criteria of applicable performance

F1	C1	C2	C3	Relative weight w_i
C1	1	1/2	4	0.32339
C2	2	1	6	0.58763
C3	1/4	1/6	1	0.08898

Table 4 The comparison matrix of the elements within the cost set under the criteria of safety performance

F2	C1	C2	C3	Relative weight w_i
C1	1	1/4	3	0.22554
C2	4	1	5	0.67381
C3	1/3	1/5	1	0.10065

Table 5 The comparison matrix of the elements within the cost set under the visual effects

F3	C1	C2	C3	Relative weight w_i
C1	1	1/3	1	0.20980
C2	3	1	2	0.54993
C3	1	1/2	1	0.24027

4.3 *Getting the Judgment Matrices and the Sorted Vectors of the Elements in the Control Layer*

Under the criteria of maximizing the value of the project, we can get the weight of the relative decision target in various criteria by using the method of AHP. Compare the function and cost and get the matrix as Table 2.

The data in the matrix are received through the conducted questionnaire survey of decision-makers, by which to reflect their views on the relative importance of the two elements. The relative weights in the last column are calculated by the formula.

In this example, the network layer contains Function set and Cost set, without considering the control layer. Use the program value as a criterion and the element in the certain set as a sub-criterion, and establish the pair wise comparison matrix. For example, under the criteria of the function set, the comparison matrixes of the elements within the cost set are as following tables (Tables 3, 4, and 5):

The resulting relative weights are the sub-blocks of the super matrix.

Similarly, we can get the remaining matrixes: (1) The comparison matrix of the elements within the function set under the criteria of the elements of the cost set; (2) The comparison of the elements within the same set under the criteria of a certain element.

Table 6 Super matrix of the elements under the criteria of the largest project value

	F1	F2	F3	C1	C2	C3
F1	0.70886	0.17212	0.08807	0.26836	0.33252	0.15705
F2	0.17862	0.72585	0.19469	0.61442	0.52784	0.59364
F3	0.11252	0.10203	0.71723	0.11722	0.13965	0.24931
C1	0.32339	0.22554	0.20980	0.66076	0.17136	0.08809
C2	0.58763	0.67381	0.54993	0.20813	0.75039	0.19470
C3	0.08898	0.10065	0.24027	0.13111	0.07825	0.71722

Table 7 Long-term weight of the super-matrix

	F1	F2	F3	C1	C2	C3
F1	0.15167	0.15167	0.15167	0.15167	0.15167	0.15167
F2	0.25585	0.25585	0.25585	0.25585	0.25585	0.25585
F3	0.09248	0.09248	0.09248	0.09248	0.09248	0.09248
C1	0.13587	0.13587	0.13587	0.13587	0.13587	0.13587
C2	0.28495	0.28495	0.28495	0.28495	0.28495	0.28495
C3	0.07919	0.07919	0.07919	0.07919	0.07919	0.07919

4.4 Construction and Calculates the Ultra-Matrix and Limit Super Matrix

ANP calculates the final weight of each interaction between the factors by using the ultra matrix formula. Super-matrix is an isolating matrix. Table 6 lists the super matrix of this example, the data of which is formed by the eigenvectors of 12 comparison matrixes of the interacting elements in Sect. 4.3. For instance: the three values from the bottom of the first column in Table 6 is the weight of the elements in Table 3 (the last column of Table 3). We can successively build up the following super matrix:

Weight the elements in the super matrix W and get the weighted super matrix $W = (W_{ij})$, in which $W_{ij} = a_{ij}\ w_{ij}$, $i = 1, \ldots, N$; $j = 1, \ldots, N$ while a_{ij} is the judgment matrix of the elements layer and W_{ij} is the sub-matrix block of each. Do the evolution on the weighted super matrix $2k + 1$ time. When k approaches to the infinity, the results achieve the consistent figures and it forms a long-term stable matrices. All the non-zero value of each row of the super matrix becomes same by now. These figures represent the weight of each evaluation index relative to the stability of the target, which is shown in Table 7.

4.5 Calculating the Comprehensive Evaluation Value of Each Alternative

The example cited six specific evaluating indicators. List the pair wise comparison matrix of the evaluating indicators of three projects and calculate the weight of

Table 8 Advantage of the projects

Project	Relative weight	Score
1. Project 1	0.614284	0.204761
2. Project 2	0.135508	0.045169
3. Project 3	0.250208	0.083403

each. We can get the final score and the advantages of each project by the process written above.

This shows that project one is the optimum project (Table 8).

5 Conclusion

According to the table above, the score of the Project 1 is the highest among all, so Project 1 can be put into effect as the optimal selection. The case studied is consistent with the fact, which verifies the feasibility of the proposed evaluation system and method. But there is still a problem remains in the subjective scoring of various indicators. If the indicators can be scored more objectively, the value of this method applied to the evaluation of the design projects will be greater.

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Empirical Study of the Production Efficiency Change of Chinese Regional Construction Industry Basing on Stochastic Frontier Analysis

Sen Lin, Zheng-fei Hu, and Guan-ping Liu

Abstract Among different regions of China, the development of construction industry are generating a growing gap. The persistent occurrence and excessive expansion of such differences will not only undermine the overall efficiency of the construction industry, but also not be conducive to the efficient allocation of resources. According to this, we explore gaps of production efficiency among a vast territory and its root causes with stochastic frontier production model. The research shows that regional scientific input, degree of the openness of construction market, the market ownership structure, and development level of industry are the four control variables promoting production efficiencies immensely while the human capital and the development of regional finance are not. The gaps of the production efficiencies among different regions are widening over time.

Keywords Construction industry • Difference • Productivity change • Stochastic frontier analysis

1 Introduction

Since the turn of this century, the Chinese construction industry has been the fourth pillar industry after manufacturing, agriculture and commerce. In 2009, the total output value of the construction industry was 135,303 billion RMB, increasing by 16.2 % over 2008 (National Bureau of Statistics of China 2009). The booming of the construction industry also promotes the relevant industries such as manufacturing,

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metalwork, construction materials and nonmetallic minerals, which thus play an irreplaceable role in keeping the Chinese regional economies advancing. However, theories and empirical studies relevant to this industry are relatively rare within the country, not in concert with the flourishing of the practice (Chau and Walker 1988). For instance, measuring the maximal output by a production unit applying the current technology, production efficiency is a most important indicator of productive performance and which importance is magnified during the economic transition period. Pitifully, production efficiency of the construction industry is rarely being taken seriously, until the work "Social and Economic Value of the Construction Industry" by David Pearce was issued in 2003.

With a vast territory, China's regional economic development is unbalanced, and so is the regional construction industries' development. The long existence and enlarging gaps not only affect the efficiency of the whole construction industry, but stand as prejudice to the effective allocation of resources. Therefore, narrowing down the gaps is a big concern for the academia, and one solution to this issue is the analysis on the difference and spatial convergence of the production efficiency change of the Chinese regional construction industries. There exist two solutions to the measurement of the input–output efficiency: the parametric way and nonparametric way. The biggest drawback of the nonparametric way is the assumption that there is no stochastic error affecting the output. The ignorance of bias will result in errors embedded in efficiency values. On the other hand, the biggest defect of the parametric way is that the optimal efficiency frontier can limit the function forms, thus also leading to bias in efficiency values (Pan and Liu 2010). Moreover, convergence means that economic convergence of each region can achieve the equally long lasting balance. Therefore, the analysis of the convergence of production efficiencies should be based on long-term time-series observed data. However, production efficiencies in different regions and different periods will be of remarkable difference, and the effect of stochastic errors will be fairly significant. Therefore, we intend to apply Stochastic Frontier Analysis (SFA) to the study of differences among production efficiencies of construction industries in different regions, and discuss the critical factors leading to these differences. Based on this, we use σ convergence test to study the convergence empirically with data sourced from Chinese regional construction industries.

2 Literature Review

Since the turn of the twenty-first century, the academia has been more and more devoted to the research on the efficiency of the construction industry. So before we started the study, we review literature related to factors influencing production efficiency. Zhi et al. (2003), based on the theories of macro economy and new economic growth, developed seven aspects of Total Factor Productivity (TFP) of the Singaporean construction industry, i.e. technical progress, labor quality, material quality, economic development, governmental administration, cyclical factors (e.g. inflation and fluctuation of energy prices), relevant industries, and construction accidents. Griliches (1980), Dacy (1965), Stocks (1981) and Allen (1985) explored the factors influencing LP of the construction industry, namely capital-labor ratio, output structure, labor quality, economic development, new technical invention, alternative building materials which can save labor and proportion of allies. Denison (1972) developed three factors which can increase production efficiency that are economic development, resource transformation, and knowledge improvement.

The most popular methodology for efficiency studying is DEA, however, production efficiencies in different regions and different periods will vary widely, and the effect of stochastic errors will be fairly significant. Therefore, compared with DEA, stochastic frontier analysis (SFA) is preferable to our study because of its effective handling method with stochastic errors. As to input indicators, labor and equipment are widely accepted; as to output indicators, gross production value is mostly recognized. When it comes to factors influencing production efficiency, labor capital, investment in science and technology, openness of markets, ownership structure, development of financial industry, and the development of construction industry are the only references that have been verified through empirical studies.

In conclusion, academia has never considered the differences existing along the development of the construction industry. Therefore, we intend to deeply analyze the differences of production efficiency changes of the Chinese construction industry among different regions, its root causes, and the dynamic changing trends, in a new perspective. Our study will extend the efficiency study to the industry level based on a convergence approach.

3 Methodology

3.1 The SFA Model

SFA, originally developed by Aigner (1977), focused on cross-sectional data during the 1970s. More recently, Battese and Coelli (1992, 1995) extended the data type to panel ones. Its fundamental principle is shown in Eq.1:

$$y = f(x;\beta) \cdot \exp(v - u) \tag{1}$$

Where y is the output, x is a vector of inputs, and β is a vector of undetermined parameters. The error term is composite, in which v is normally distributed as $N(0,\sigma_V^2), v \in iid. u \geq 0$, and it stands for the impact on a specific unit. Therefore, the production efficiency of this unit can be denoted as $TE = \exp(-u)$ (Kumbhakar et al. 2003). When $u = 0$, the unit lies on the production frontier, and when $u > 0$, the unit lies below the frontier, i.e., it is inefficient Battese (Meeusen and van Den Broeck 1977) and Battese et al. (1992) further improved this model to handle panel data of N units in T periods, and to be able to quantify the role of various factors in the changes of production efficiency, thus becoming the classic model widely used by follow-up researchers. Its basic principle is shown as follows:

$$\ln(y_{it}) = \beta_0 + \sum_n \beta_n \ln(x_{it}) + v_{it} - u_{it} \tag{2}$$

$$M_{it} = \delta_0 + \delta_i \cdot z_{it} + \varepsilon_{it} \tag{3}$$

$$TE_{it} = \exp(-u_{it}) \tag{4}$$

$$\gamma = \frac{\sigma_u^2}{\sigma_u^2 + \sigma_v^2} \tag{5}$$

where i is the number of units being evaluated, t is the number of periods, $t = 1, 2, \ldots, T$; y is the dependent variable, x is the vector of explanatory variables; β_0 is the intercept item; β_n is the vector of undetermined parameters. The error item of Eq. 2 is composed of two parts. The first part v_{it} is normally distributed as $N(0,\sigma_v^2)$, where $v_{it} \in iid$. The second part $u_{it} \geq 0$ and $\in iid$, and it reflects the stochastic impact on Unit i in Period t. Hereby we assume that u_{it} is normally distributed as $N(M_{it},\sigma_u^2)$. u_{it} and v_{it} are mutually independent.

In Eq. 3, z_{it} is the factor influencing the production efficiency; δ_i is the vector of undetermined parameters, reflecting the impact of z_{it} on production efficiency.

Equation 4 denotes the production efficiency of Unit i in Period t. Apparently, if $u_{it} = 0, TE_{it} = 1$, which means that this unit lies on the efficiency frontier. In contrast, if $u_{it} > 0, 0 < TE_{it} < 1$, which means during the period the unit lies below the frontier, so it is inefficient.

In Eq. 5, γ is the parameter to be determined. Apparently, if $\gamma = 0$, namely $\sigma_u^2 \to 0$, we can get $\varepsilon_{it} = v_{it}$. In statistical tests, if the null hypothesis of $\gamma = 0$ is accepted, all units being evaluated lie on the production frontier. As a result, we have no need to use SFA, but rather use OLS (Ordinary Least Squares) directly.

3.2 Indicators Selection and Data Acquisition

3.2.1 Indicators Selection

According to the model and literature review by Battese and Coelli (1995), we construct our own model:

$$\ln(GPOCI) = \beta_0 + \beta_1 \ln(EXE) + \beta_2 \ln(NVCI) + v_{it} - u_{it} \tag{6}$$

$$M_{it} = \delta_0 + \delta_1 C_1 + \delta_2 C_2 + \delta_3 C_3 + \delta_4 C_4 + \delta_5 C_5 + \delta_6 C_6 \tag{7}$$

$$TE_{it} = \exp(-u_{it}) \tag{8}$$

$$\gamma = \frac{\sigma_u^2}{\sigma_u^2 + \sigma_v^2} \tag{9}$$

Table 1 Descriptive statistical analysis of the indicators

Variables	Sample sizes	Means	Standard deviation	Minimums	Maximums
GPOCI	248	9,098,573	10,609,570	168,178	70,105,724
EXE	248	39.2980	37.2569	0.7475	262.8806
NVCI	248	751,524	636,881	14,509	4,009,178
C_1	248	0.8176	0.1164	0.3990	1.1724
C_2	248	0.1677	0.1356	0.0052	0.8411
C_3	248	0.0092	0.0107	0.0000	0.0571
C_4	248	0.6160	0.1660	0.1911	0.9480
C_5	248	1.0352	0.3290	0.5372	2.4002
C_6	248	0.1604	0.0589	0.0568	0.3800

where *GPOCI* is the gross production value of the construction industry, or the output; *EXE* is the total wages of the staff, or the input of labor; *NVCI* is the total power of machinery and equipment owned by the end of the year, or the input of equipment. Based on the achievements, we select six control variables: C_1 stands for the average wages of construction industry staff divided by the average wages of the whole regional industry; C_2 stands for the total scientific funds raised divided by the regional financial expenditure; C_3 stands for the assets of the foreign-owned enterprises divided by the total assets of the whole construction industry; C_4 stands for the assets of the non-state enterprises divided by the total assets of the whole construction industry; C_5 stands for the total loans of financial institutions divided by the regional gross domestic product (GDP); C_6 stands for the gross production values of the regional construction industry divided by the regional GDP.

3.2.2 Data Acquisition

According to the above analysis, we collect and classify data sourced from "China Statistical Yearbook" and "China Financial Industry Yearbook", both from the year of 2001 to 2009. Descriptive statistical analysis of the variables we select is shown in Table 1.

3.3 Empirical Study

We process the data using the software Frontier 4.1, i.e., the classic model of Battese and Coelli (1995). See Table 2 for the results.

From Table 2, we can clearly draw the following conclusions.

1. The model structure. The value of γ is 0.999, and the LR statistical test is significant when the level of significance is 1 %, indicating that the error item is distinctly composite. Therefore, SFA is applicable.

Table 2 Results of the Sfa model by Frontier 4.1

	NL estimated value	Standard deviation	T-test
A. Production function			
Intercept	9.0372	0.3477	25.99
β_1	0.5064	0.0416	12.18
β_2	0.4616	0.0518	8.91
B. Technically inefficient function			
Intercept	1.0160	0.4360	2.33
δ_1	0.6117	0.1742	3.51
δ_2	−0.9000	0.1763	−5.11
δ_3	−14.3945	1.9269	−7.47
δ_4	−0.3796	0.1615	−2.35
δ_5	0.6062	0.0802	7.56
δ_6	−2.7501	0.3899	−7.05
C. Variance parameter			
δ^2	0.0473	0.0048	9.90
γ	0.99999999	0.1528	6.55

log likelihood function = 27.2612; LR test of the one-sided error = 196.3831

Table 3 Average production efficiencies, national and regional

	2000	2001	2002	2003	2005	2006	2007	2008
The nation	0.2443	0.2666	0.2565	0.2839	0.3520	0.3768	0.4150	0.4367
The east	0.2943	0.3250	0.3242	0.3636	0.4560	0.4844	0.5298	0.5469
The middle	0.2248	0.2546	0.2364	0.2661	0.3304	0.3545	0.3931	0.4230
The west	0.2114	0.2211	0.2079	0.2226	0.2709	0.2931	0.3242	0.3448

2. The output elasticity of inputs. $\beta_1 = 0.5064$, indicating that when the input of labor increases by 1 %, the production efficiency increases by 0.5064 %, so does β_2. Compared with increasing the input of equipment, increasing the input of labor is more beneficial to production efficiency.
3. Control variables. Among the six control variables, δ_2, δ_3, δ_4, and δ_6 promote production efficiency significantly. In contrast, δ_1 and δ_5 have negative effects on production efficiency.
4. Regional efficiency. The averages of the production efficiencies, both national and regional, over the past 9 years, are shown in Table 3. Herein, our principle of categorizing is: the eastern region contains Beijing, Tianjin, Shanghai, Liaoning, Jiangsu, Zhejiang, Fujian, Guangdong, Hainan, and Shandong, totaling 10 provincial-level administrative units; the middle region contains the eight provinces Shanxi, Jilin, Heilongjiang, Anhui, Jiangxi, Henan, Hubei, Hunan; the western region contains 12 provincial-level administrative units Inner Mongolia, Guangxi, Sichuan, Guizhou, Yunnan, Shanxi, Gansu, Qinghai, Ningxia, Chongqing, Tibet, and Sinkiaing.

Currently, the production efficiencies of the Chinese construction industry vary among different regions, declining gradually from the east to the west. This obviously indicates that production efficiency is positively correlated with the level of economic development. Further, production efficiency increases steadily, from 0.2443 by the turn of the century, to 0.4376 in 2008. According to our investigation, there are three reasons for this increase. First, with the acceleration of the marketization of the construction industry, construction enterprises are strengthening their sense of competition, which in turn leads to the promotion of their production efficiencies. Second, as foreign direct investment (FDI) keeps pouring into the nation, along with it comes in advanced technical and managerial concepts and methods, which are the main driving forces for the promotion of production craftsmanship. Third, the increasing investment in scientific research and development by the national and local governments has also contributed to the structural upgrading of the construction industry. However, with the still relatively low efficiency score of 0.4376, the production efficiency of the Chinese construction industry still need to be increased.

4 Conclusion

We analyze in depth the differences of production efficiency changes of the construction industry among different regions in China, their root causes, and the dynamic changing trends, in a new perspective, so as to extend the current efficiency study to the industry level based on a convergence approach. The research shows an obvious feature of ladder-like distribution with a decreasing trend from the east coastal area to the middle and west areas. Regional scientific and technological input, degree of the openness of the construction market, the market ownership structure, and development level of industry are the four control variables promoting production efficiencies immensely. In contrast, the human capital and the development of regional finance negatively affect production efficiency. The gaps of the production efficiencies among different regions are widening over time. Therefore, we suggest that regional protectionism should be suppressed seriously in order to promote the exchange of advanced technical and managerial ideas and craftsmanship between different regions.

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Factor Analysis and Clustering-Based Empirical Study on Regional Construction Industry Development in China

Ya-yun Dang and Xing Bi

Abstract The purpose of the study is to provide suggestions for policy-makers and industry practitioners aiming at improving the construction industry development. This paper constructs a complete evaluation index system of regional construction industry development, and then applies factor analysis and clustering to analyze and evaluate the development level of construction industry of 31 regions in China by using SPSS 18.0. These 31 regions are categorized into five clusters by four extracted factors, namely total factor, efficiency and technology factor, per capita factor and profitability factor. The results show that significant differences exist in development level of construction industry among different regions.

Keywords Clustering • Development • Factor analysis • Regional construction industry

1 Introduction

Construction industry is one of the pillar industries in China. Evaluation on construction industry development can reflect the differences of regional construction industry and can guide the market to allocate resources efficiently, thereby improving the overall competitiveness of China's construction industry. There are two types of evaluation methods (Wang Jia-yuan and Yuan Hong-ping 2007), namely subjective method and objective method. The former determines the weight of each evaluation index by experts' subjective judgment according to their own knowledge and experience, such as analytic hierarchy process, fuzzy comprehensive evaluation, etc.; the latter determines the weight according to the objective relationship between

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the indexes, such as DEA (data envelopment analysis), principal component analysis, etc. (Xue et al. 2008; Taewoo Youa and Hongmin Zib 2007; Tsolas 2011; Ruan Lian-fa and Zhang Yue-wei 2009; Deng Rong-hui and Xia Qing-dong 2006; Kang Xue-zeng and Meng Gang 2008). However, there are some deficiencies of these methods: due to the limitations of experts' knowledge and experience, differences exist between expert's weights and actual situation, which influences evaluation results; information overlap or high correlation between indexes makes the results not tally with actual situation.

Some scholars apply cluster and factor analysis to the research of the sustainable development, growth levels of construction industry, having achieved valuable results (Wang Lei et al. 2006; Wang Xue-qing et al. 2011; Kale and Arditi 2002; Wang Wen-xiong and Li Qi-ming 2008; Zhou Jian-hua and Yuan Hong-ping 2007). However, the indexes selected are incomplete. Therefore, on the basis of widely collecting and sorting the existing evaluation index, this paper proposes an evaluation index system, which can reflect the construction industry development and is also suitable for factor analysis and clustering. By adopting the data of China Statistical Yearbook 2011, the paper evaluates the construction industry development of 31 regions in China and categorizes them based on regional similarity through cluster analysis.

2 Methodology

2.1 Factor Analysis

The purpose of factor analysis is to describe the covariance relationships among observed and correlated variables in terms of a few underlying but unobserved random quantity variables called factors. In other words, it is possible that variations in three or four observed variables mainly reflect the variations in fewer unobserved variables. Factor analysis searches for such joint variations in response to unobserved latent variables. The observed variables are modeled as linear combinations of the potential factors, plus "error" terms and the factor model is motivated by the hypothesis that variables can be grouped by their correlations (DeCoster 1998; Factor Analysis 2013).

2.2 Hierarchical Clustering

Cluster analysis is a task of grouping a set of objects in such a way that objects in the same group (called cluster) are more similar (in some sense or another) to each other than to those in other groups (clusters). It is a main task of exploratory data mining, and a common technique for statistical data analysis (Du Gang 2003).

Table 1 Evaluation index system

First-level	Second-level
Industry scale	X1 Number of enterprises (unit)
	X2 Number of employed persons (person)
	X3 Total assets (10,000 yuan)
	X4 Gross output value (10,000 yuan)
	X5 Value added of the construction industry (10,000 yuan)
Per capita level	X6 Per capita GDP (10,000 yuan/person)
	X7 Per capita profit (10,000 yuan/person)
Profitability	X8 Rate of return on common stockholders' equity (%)
Performance	X9 Total tax (10,000 yuan)
	X10 The proportion of employment (%)
	X11 Overall labor productivity in terms of gross output value (yuan/person)
Technology	X12 Total number of machinery and equipment owned (set)
	X13 Total power of machinery and equipment owned (10,000 kw)
	X14 Net value of machinery and equipment owned (10,000 yuan)
	X15 Value of machines per laborer (yuan/person)
	X16 Power of machines per laborer (kw/person)

Hierarchical clustering is based on the core idea of objects being more related to nearby objects than to objects farther away. As such, these algorithms connect "objects" to form "clusters" based on their distance. A cluster can be described largely by the maximum distance needed to connect parts of the cluster. At different distances, different clusters will be formed, which can be represented by a dendrogram.

3 Evaluation Index System

According to the principle of purposefulness, scientificalness, integrity, and operability and base on relevant researches, the paper designs an evaluation index system (see Table 1) to reflect construction industry development. The index system includes two hierarchies: first-level indexes and second-level indexes. First-level indexes contain six indexes, which are six aspects of construction industry development; Second-level indexes consist of 16 basic indexes.

4 Factor Analysis & Results

Based on the evaluation index system, the paper analyzes and evaluates construction industry development of 31 provinces in China by using SPSS 18.0 with data collected from China Statistical Yearbook (2011).

Table 2 KMO test results and Bartlett test results

Kaiser-Meyer-Olkin measure of sampling adequacy		0.721
Bartlett's Test of Sphericity	Approx. Chi-Square	817.557
	df	120
	Sig.	.000

Table 3 Characteristic value and contribution rate of common factors

Common factor	F_1	F_2	F_3	F_4
Characteristic value	8.525	2.424	2.155	1.095
Contribution rate/%	53.281	15.148	13.471	6.845
Accumulative contribution rate/%	53.281	68.429	81.901	88.746

4.1 KMO Test and Bartlett's Test of Sphericity

KMO Test measures whether the samplings are enough for factor analysis and whether the partial correlation coefficient between the variables is too small. Bartlett's Test of Sphericity tests whether correlation coefficient matrix is a unit matrix. If it is a unit matrix, it is not suitable for adopting factor model (Table 2).

Kaiser gave the KMO Test standard about whether it is suitable for factor analysis: KMO > 0.9, quite suitable; 0.9 > KMO > 0.8, suitable; 0.8 > KMO > 0.7, generally suitable; 0.7 > KMO > 0.6, not quite suitable; KMO < 0.5, not suitable. SPSS results show that the variables have passed the KMO Test passes. And Bartlett's Test of Sphericity = 817.557; significance = .000, which means that the variables have passed Bartlett's Test of Sphericity. So the variables that the paper selects are suitable for factor analysis.

4.2 Factor Analysis Process and Results

In the process of factor analysis, the paper extracts four common factors by principal components method. Then by using Quartimax method to rotate the factor load matrix, we can obtain the factors' scree plot (see Fig. 1), characteristic value and contribution rate (see Table 3), and rotated component matrix (see Table 4).

Table 3 shows that the accumulative contribution rate of four extracted common factors is 88.745 %, which is bigger than 85 %, i.e., the extraction of common factor is effective. The original 16 indexes can be integrated into four common factors: F_1, F_2, F_3 and F_4. According to the principle of factor analysis, the four common factors have no correlation with each other, but each common factor is highly correlated with its own contained original variables.

Table 4 shows the correlation coefficient between common factors and their own contained original variables. The first common factor F_1 has a large load in Number of Enterprises (X_1), Number of Employed Persons (X_2), Total Assets (X_3), Gross

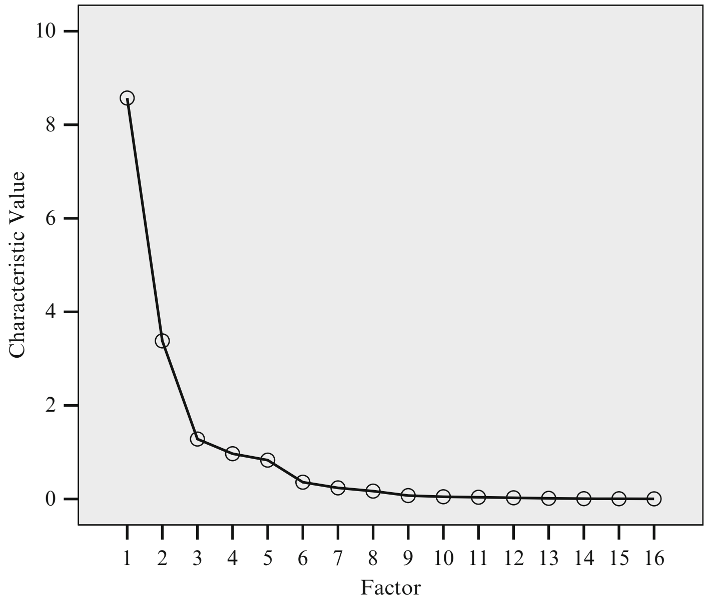

Fig. 1 Scree plot

Table 4 Rotated component matrix

Variable	Common factor F_1	F_2	F_3	F_4
X_1	0.939	−0.071	0.034	0.076
X_2	0.946	−0.211	−0.168	0.031
X_3	0.822	0.031	0.484	−0.153
X_4	0.984	−0.057	0.094	−0.033
X_5	0.977	−0.130	−0.051	0.059
X_6	−0.064	0.486	0.798	−0.230
X_7	−0.013	0.250	0.908	0.226
X_8	0.278	−0.189	0.018	0.902
X_9	0.978	−0.067	0.102	0.001
X_{10}	0.791	−0.021	0.172	−0.082
X_{11}	0.174	0.597	0.378	−0.303
X_{12}	0.772	0.234	−0.368	0.061
X_{13}	0.939	0.070	−0.186	0.156
X_{14}	0.973	0.125	−0.076	0.077
X_{15}	−0.116	0.882	0.242	−0.075
X_{16}	−0.136	0.896	0.031	0.059

Output Value (X_4), Value Added of the Construction Industry (X_5), Total Tax (X_9), The Proportion of Employment (X_{10}), Total Number of Machinery and Equipment Owned (X_{12}), Total Power of Machinery and Equipment Owned (X_{13}) and Net Value of Machinery and Equipment Owned (X_{14}). These ten indexes reflect the scale, economic and social benefits, equipment and assets of regional construction industry, so F_1 can be denominated Total Factor.

The second common factor has a large load in Overall Labor Productivity In Terms of Gross Output Value (X_{11}), Value of Machines per Laborer (X_{15}) and Power of Machines per Laborer (X_{16}). These three indexes reflect the labor productivity and technological level, so F_2 can be denominated Productivity and Technology Factor.

The third common factor has a large load in Per capita GDP (X_6) and Per capita Profit (X_7), both of which reflect the Per capita level. So F_3 can be denominated Per capita Factor.

The fourth common factor has a large load in Rate of Return on Common Stockholders' Equity (X_8), which reflects profitability of construction industry in different regions. So F_4 can be Profitability Factor.

As a result, it is suitable to use Total Factor (F_1), Productivity and Technology factor (F_2), Per capita Factor (F_3) and Profitability Factor (F_4) to represent the original variables and evaluate regional construction industry development.

By using SPSS 18.0, it is easy to obtain the scores and rankings of each common factor of 31 regions. Set contribution rates of each common factor as weight and conduct linear weighted summation to obtain comprehensive scores and rankings (see Table 5). The calculation formula of comprehensive scores is as follows:

$$F = 0.5328 \times F_1 + 0.1515 \times F_2 + 0.1347 \times F_3 + 0.0685 \times F_4 \tag{1}$$

5 Clustering & Results

Take the Total factor, Productivity and Technology Factor, Per capita Factor and Profitability Factor as independent variables for cluster analysis and adopt method of between-groups linkage and measure of squared Euclidean distance to conduct hierarchical cluster analysis to generate Dendrogram (see Fig. 2).

6 Discussion

From comprehensive score and ranking Table 5 and clustering, 31 regions can be categorized into five clusters.

The first cluster includes Beijing and Shanghai. The respective comprehensive rankings of these two regions are 3rd and 7th, with Total Factor 10th and 9th, Productivity and Technology Factor 9th and 16th, Per capita Factor 1st and 2nd, but the respective rankings of Profitability Factor are 30th and 27th, which have an obvious gap with former factors. Therefore, it can be categorized as: upper-middle scale, medium productivity and technology, high per capita and low profitability.

Table 5 Factor analysis results and clustering result of 31 regions

Region	F_1	Ranking	F_2	Ranking	F_3	Ranking	F_4	Ranking	F	Comprehensive ranking	Category
Jiangsu	3.38454	1	0.30451	8	−0.61225	25	0.59196	11	1.80744	1	2
Zhejiang	2.53706	2	−0.93329	26	−0.00682	11	−0.83078	26	1.15261	2	2
Beijing	0.29112	10	0.28406	9	4.05507	1	−1.40912	30	0.64798	3	1
Shanghai	0.36707	9	−0.05795	16	1.94079	2	−0.90358	27	0.38642	7	1
Tianjin	−0.03938	15	3.00921	1	0.71542	5	−0.5748	21	0.49197	6	3
Inner Mongolia	−0.78362	25	−0.46372	22	1.01052	3	2.94336	1	−0.15032	16	4
Tibet	−1.12967	31	0.03901	14	0.97046	4	2.00191	2	−0.32833	22	4
Liaoning	0.56047	6	−0.08053	17	0.21425	8	0.6265	10	0.35813	9	5
Shandong	1.143	3	−0.29276	18	−0.38631	21	1.03014	3	0.58307	4	5
Hubei	0.54115	7	1.30249	5	−0.12495	12	0.76541	5	0.52118	5	5
Guangdong	0.68726	4	0.05858	13	0.17083	10	−0.35474	17	0.37379	8	5
Henan	0.67475	5	0.163	11	−0.81284	29	0.44696	12	0.30528	10	5
Hebei	0.21563	11	1.44212	3	−1.0044	30	0.73982	7	0.24868	11	5
Hunan	0.01576	14	0.09016	12	−0.58511	24	0.78936	4	−0.00277	12	5
Shaanxi	−0.12515	16	0.16529	10	−0.1617	13	−0.65898	22	−0.10849	13	5
Shanxi	−0.30732	18	0.58469	7	−0.3729	20	−0.52528	19	−0.16132	18	5
Xinjiang	−0.83682	27	1.36558	4	−0.27757	15	−0.11028	16	−0.2839	21	5
Qinghai	−0.69874	23	1.79	2	−1.31179	31	−0.95352	29	−0.34302	23	5
Ningxia	−1.03269	29	0.59314	6	−0.28114	16	−0.40043	18	−0.52562	27	5
Heilongjiang	−0.43758	19	0.03453	15	0.17537	9	0.64709	9	−0.16003	17	5
Chongqing	−0.15587	17	−1.31639	29	0.32491	7	0.76306	6	−0.18652	19	5
Jilin	−0.76165	24	−0.60312	25	0.50495	6	0.71074	8	−0.38055	24	5
Sichuan	0.39812	8	−1.53913	31	−0.32963	19	−0.67853	23	−0.11187	14	5
Anhui	0.02348	13	−0.4327	20	−0.52445	23	−0.03516	15	−0.12609	15	5
Fujian	0.09295	12	−1.13986	28	−0.44119	22	−0.80451	16	−0.23762	20	5
Jiangxi	−0.5646	21	−0.95296	27	−0.1685	14	−0.00593	14	−0.4683	25	5
Yunnan	−0.54731	20	−0.58027	24	−0.29882	18	−0.78121	23	−0.4732	26	5
Gansu	−0.82707	26	−0.43852	21	−0.63827	26	0.28323	13	−0.5737	28	5
Guangxi	−0.69726	22	−0.35711	19	−0.64669	27	−0.94365	28	−0.57725	29	5
Guizhou	−0.90287	28	−0.57797	23	−0.80489	28	−1.82726	31	−0.80202	30	5
Hainan	−1.08479	30	−1.4601	30	−0.29235	17	−0.54179	20	−0.87562	31	5

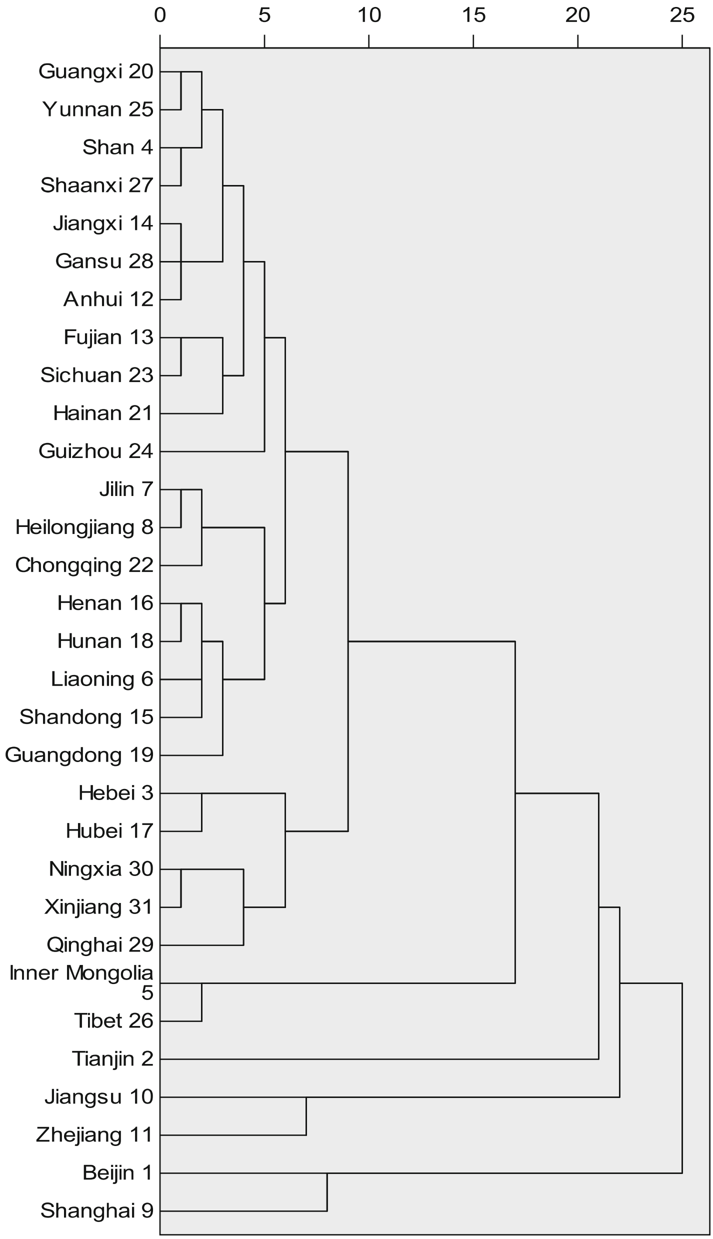

Fig. 2 Cluster genealogy chart

The second cluster includes Jiangsu and Zhejiang. The respective comprehensive rankings of these two regions are 1st and 2nd, and Total Factor also 1st and 2nd. But the other three common factors all rank low. It can be concluded that Total Factor has a huge impact on comprehensive ranking. The scores of Total Factor are 3.38454 and 2.53706 respectively, and much higher than Shandong' score of 1.143, which ranks 3rd. These two regions can be categorized as: large scale, medium-lower productivity and technology, medium-lower per capita and profitability.

Tianjin is a special region and can be categorized by itself. Its score of Total Factor ranks 15th, but Productivity and Technology Factor scores 3.00921 and ranks 1st, much higher than the 2nd ranking score of 1.79 of Qinghai; its score of Per capita Factor ranks 5th, but Profitability Factor 21st. The comprehensive ranking is 6th, which shows that Productivity and Technology Factor improves the comprehensive score a lot and the construction industry of Tianjin is developing towards high productivity and technology. It can be categorized as: middle scale, high productivity and technology, high per capita and medium-lower profitability.

The fourth cluster includes Inner Mongolia and Tibet, the comprehensive ranking of which are 16th and 22nd. The scores of Per capita Factor ranks 3rd and 4th, and Profitability Factor 1st and 2nd. But the score of Total Factor and Productivity and Technology Factor are ranking low. It indicates that the construction industry of Inner Mongolia and Tibet is small-scale, low-productive and low-technological, but due to their small population both of the per capita level and profitability are high. It can be categorized as: small scale, low productivity and technology, high per capita and profitability.

The fifth cluster includes the rest 24 regions. The comprehensive scores of these 24 regions span from 0.58307(Shandong) to −0.87562 (Hainan), and they represent the basic development situation of China's construction industry. The score of each common factor in these regions is not high, which shows that the overall development of China's construction industry is not good and it is still in primary stage no matter from which point of view of the scale, productivity and technology, per capita or profitability. This cluster can be classified as: middle scale, medium productivity and technology, medium per capita and profitability.

7 Conclusion

The study constructs an index system, and then applies factor analysis and cluster analysis to conduct an empirical study on construction industry development of 31 regions in China by using SPSS 18.0. All regions are categorized into five clusters by four extracted factors: total factor, efficiency and technology factor, per capita factor and profitability factor. And the results show that significant differences exist in development level of construction industry among different regions. The purpose of the paper is to help policy-makers and industry practitioners find their own positions, and improve competitiveness.

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Research on the Emergency Management Strategies of China High-Speed Railway Based on Risk Network Theory

Yun-yi Zhang, Nai-ding Yang, and Dan-ping Zhang

Abstract Safe operation and rapid emergency response are taken as preconditions to develop China high-speed railway. From the perspective of a whole life cycle, this paper identifies the key risk factors of China high-speed railway by utilizing the risk network theory and proposes some emergency management strategies accordingly. Early warning and prevention of safety crisis in China high-speed railway emergency management is emphasized particularly. The proposals may help to promote the emergency management capability of China high-speed railway.

Keywords Emergency management • High-speed railway • Risk network • Strategy

1 Introduction

China high-speed railway has some world-class technologies, however, its management, services, especially the emergency response capabilities, cannot keep pace with the rapid technological development. The problems arisen from the "7·23" major accident on Wenyong Line, such as the quality of equipment and personnel, on-site control, indicate that the safety management and emergency response capabilities of China high-speed railway are still far from enough. Social consensus considers that if high-speed railway could be vigorously developed in China, the operational safety and emergency response capabilities should be taken as the preconditions.

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In accordance with the present situation of China's high-speed rail, the scholars mainly carried out two aspects of researches, namely the safety supervision and emergency response of China high-speed railway. As far as safety supervision is involved, the scholars mainly from the perspective of risk management, put forward their solutions to the key risk factors that may interfere with the safety operation of the high-speed railway. Y.Q. Tang (2011), W.Q. Li (2010) and C. Tang (2010) hold that human is the key factor that interferes with the safety operation of the high-speed railway, therefore, they proposed that it is a best choice to strengthen staff training, incentives, assessment and psychological counseling in effectively enhancing the safe operation. F. Wei (Fu 2012) took the public works sector of Zhengzhou-Xi'an high-speed rail as an example, and mainly explained the risk management responsibilities, risk identification and risk control of high-speed railway and proposed relevant solutions; M.J. Cai (2012), J.E. Bao (2012) and H. Li (2012) respectively took quality supervision on the construction site, communication safety management and vehicle service safety management as the key risk factors and proposed relevant solutions.

In emergency response, H.Y. Yan et al. (2012), X.J. Hou (2010), Q.W. Yan (2011) and some others put forward their emergency management plans from a technical point of view according to the most common equipment failures of different CRH trains; Q.X. Guo (2012) made an analysis on the emergency communication system in times of high-speed rail and proposed his plan on the construction and optimization of China railway emergency communication system. From the management perspective, H. Zhao (2011) and L.S. Gu (2011) introduced the advanced management experience concerning high-speed railway in Japan, France and Germany, and provided their valuable advice on the development of China high-speed railway in three aspects, namely, technological innovation, improving legislation and operational management system as well as strengthening the emergency response system construction; H.W. Ai et al. (2008), W.J. Wang et al. (2006), and C. Lu and L.S. Zhou (2008), by building high-speed railway emergency plan procedure models with computer technologies, provided their proposition for the formation of China high-speed railway emergency plan; K.Y. Sun (2012) put forward his suggestions to improve China high-speed railway safety and emergency response capabilities from the view of high-speed railway emergency response decision support systems.

These studies above have provided great help to the improvement of China high-speed railway safety and emergency response capabilities. However, there is still something to be improved in these researches. For example, instead of applying systematic theories as guidance, these researches simply listed part of the problems encountered in work situations concerning the security risk factors identification of China high-speed railway. Although some scholars used the Bayesian network theory to analyze risk factors of large-scale projects, what they did was to analyze some detailed parts of the project instead of analyzing the risk factors of the whole process of the project (Zhou and Peng 2009). As for their researches on China's high-speed railway emergency response, they were limited to the response propositions and response plans for incidents that already occurred rather than taking the emergency management as a whole process which includes the dynamic process of reduction, readiness, response and recovery. But the limitations bring a lot of enlightenment to this paper.

2 Methodology

The difference from other similar researches is that this paper identifies the key risk factors in China high-speed railway from life cycle perspective by applying the risk network theory which is widely used in large-scale projects. Based on this, puts forward the strategies for China's high-speed rail emergency management and propose some advices to the prevention of potential risks in China high-speed railway.

2.1 Definition of Risk Network

China high-speed railway involves plenty of technology R & D work, precision coordination and management, therefore lots of uncertainty and risks exist. The causes and consequences of risks are not a simple causal relationship, there also involves the interaction and coordination of different relations. If these relationships are expressed, they constitute a network, and this network used for the analysis of the risks is called a risk network.

The risk network for China high-speed railway project can be denoted as:

$$G = (V, E) \tag{1}$$

In this equation, V stands for the set of nodes, E is the set of relations. In this definition, the set of nodes V contains risk information, risk factors, risk events, and risk loss, etc., while the set of relations E indicates linkages between the nodes.

2.2 Risk Network Construction Method for High-Speed Railway

The two steps to construct the risk network of the high-speed railway project are risk identification and network construction. The risk identification of China high-speed railway is done on the basis of discomposing the work structure and risk structure by applying systematic analysis to identify the risk factors. This paper takes the life cycle theory to guide the work structure decomposition of China high-speed railway for the reasons that: firstly, at different stages in the life cycle of the construction

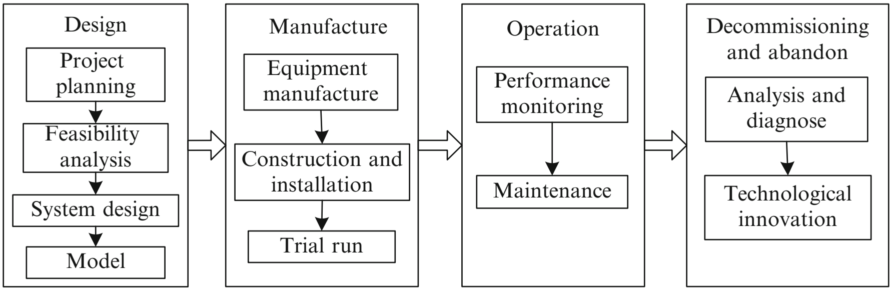

Fig. 1 Whole life cycle of the high-speed railway

project, the construction contents, tasks and resources may differ greatly, therefore the risk factors that influence the construction tasks at different stages of the project may also vary. Secondly, from the overall point of view, in the risk analysis of a construction project all risk factor at different stages are inter-related and are in one time sequence. The whole life cycle of the high-speed railway project in this paper includes the four stages, that is, design, manufacture, operation, decommissioning and abandon, as shown in Fig. 1. Stage "Design" are mainly about project planning, feasibility analysis, system design and model experiment. Stage "Manufacture" are mainly about equipment manufacture, construction and installation and trial run. Stage "Operation" includes performance monitoring and maintenance. Stage "Decommissioning and abandon" includes analysis and diagnose and technological innovation.

In order to accurately identify the risk factors for China high-speed railway and sort out the complex relationship between the risk factors, by organizing the data and documents, this paper first made a list of the risk factors and risk events throughout the life cycle of the high-speed railway. After discussions with experienced experts in the fields of project construction and management, selected the key risk factors directly related to the safety of China high-speed railway and constructed the risk network. Based on this risk network, the strategies for high-speed rail emergency management are proposed.

3 Results

3.1 Risk Network for China High-Speed Railway

There are four phases in the life cycle of China high-speed railway: design, manufacture, operation and decommissioning. There are different tasks in each phases, the risk factors contained in these tasks are interrelated and influence each other, which constitute the risk network of the China high-speed railway.

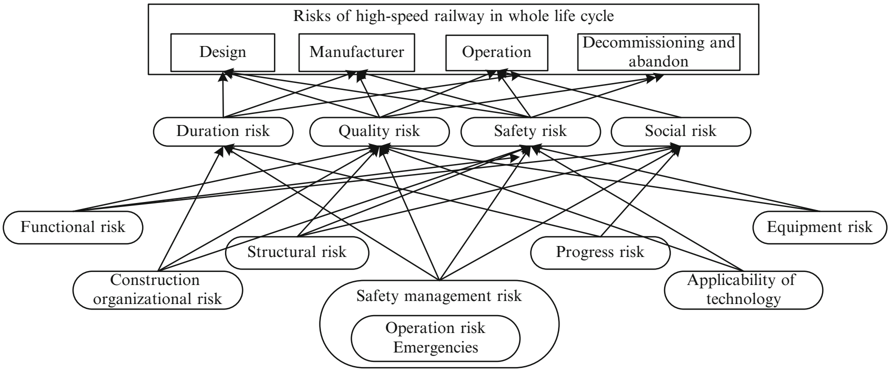

Fig. 2 Risk network of China high-speed railway

Figure 2 indicates that there are four major risks in the whole life cycle of China high-speed railway, which are duration risk, quality risk, safety risk and social risk. These risks are caused by some basic risks, such as function risk, structural risk, progress risk, equipment risk, construction organization risk, safety management risk for operation and emergencies, and applicability of technological, etc.

Meanwhile, it is obtained that each phase of life cycle has its own focus on risk factors by combing all the risk factors and risk events of China high–speed railway. In the phases of design and manufacture, the major basic risk factors are function risk, progress risk, structure risk, equipment risk, construction organization risk, safety management risk, which will lead to the duration risk, quality risk and safety risk. In the phase of operation, the major basic risk factor is safety management risk for operation and emergencies, which will lead to safety risk and social risk. In the phase of decommissioning and abandon, the major basic risk is applicability of technological, which is related to technical innovation of China high-speed railway and will influence the duration, quality and safety of a new generation of high-speed railway.

3.2 The Strategies of the China High-Speed Railway Emergency Management

Most of the people think emergency management of high-speed railway refers to the appropriate disposal policy and settlement when the emergencies happen during the operation. However, according to the life cycle, the performance of each phase influences that of the next one, meanwhile, the risk factors contained in each phase will be passed to the next phase and lead to worse safety problems of high-speed railway. So the emergency management of high-speed railway is an integrated, dynamic process that includes crisis management before and after the emergencies happen, the purpose of which is to avoid public safety emergency incidents, to minimize the hazard or eliminate such emergencies.

Table 1 The strategies of high-speed rail emergency management

Life cycle stage	Basic risk factors	Management tasks	Emergency strategies
Design and manufacture	Function risk, progress risk Structure risk, equipment risk Construction organization risk Safety management risk	Identify quality and safety risks Enhance safety skills and emergency awareness of the staff	Early alarm before the crisis Drawing pre-plans
Operation	Day-to-day operation Emergencies	Monitor and maintain safe operation Effectively respond to emergencies Reduce social hazard	Emergency response disposal Accident analysis and settlement
Decommissioning and abandon	Applicability of technological innovation	Elevate quality Improve safety performance	Post-crisis restoration and upgrading

The main contents of emergency management shall include: crisis prevention and early warning, emergency plan formulation, emergency rescue and accident analysis, post-processing of the event, the construction of emergency management system and so on.

The basic targets of high-speed railway emergency management shall include: the ability to recognize and identify potential threats, to monitor and maintain the operation of high-speed rail and minimize the hazard or eliminate such emergencies; ensure response plans or strategies in case any threats (including natural disasters or emergency events) occur; assist the threatened high-speed rail to restore normal operation as soon as possible; improve the emergency awareness and safety skills of the employees so that the efficiency and effectiveness in disaster alleviation may be enhanced and operation coordination may be enhanced.

Aimed at the specific risk factors of each phase in the life cycle, the contents and targets of emergency management of China high-speed railway have their own focus and the strategies are different in each phase. Summarized as Table 1. The Specific approaches of each strategy will be discussed in next section.

4 Discussion

It is a most challenging system engineering to improve China high-speed railway emergency management, which is of great significance to ensure rapid, efficient and orderly response to all kinds of crises and unexpected security incidents in the operation of high-speed railway.

As what has been mentioned before, the performance of each phase in the life cycle of high-speed railway influences that of the next one. The risk factors contained in each phase will be passed to the next phase and lead to worse safety problems of high-speed railway. So, the front phase must be paid more attention. As we can see from the Table 1, in the design and manufacturing phases, there are more inherent risks in the high-speed railway. In another word, the phases of design and manufacture determine the operation safety of high-speed railway. It is inferred that prevention and early warning before emergencies occurrences occupy more important position in China high-speed railway emergency management.

4.1 The Approaches of Prevention and Early Warning in Design and Manufacturing Phases

4.1.1 Improve the Qualities of Designer and Constructors

It is obvious that high-speed railway is knowledge-intensive and technology-intensive, especially in the phases of design and manufacture. The two phase include project planning, feasibility analysis, design and manufacture the entire high-speed railway system, wind tunnel testing and structural testing and test run, etc. Human being is the key factor at these two phases, because most of the work at this stage is done by the wisdom of the people. It is evident that the technical capacities, attitudes, awareness, physical and mental health of all personnel involved in the design and construction of high-speed railway and to some extent will decide the level operation safety as well as implementation of the high-speed railway in the future.

Therefore, in these phases, the approaches should focus on the job security qualifications as well as knowledge and skill levels of the designers and the constructors. At the same time, scientifically organizing the constructions, strictly implementing safety rules and regulations, and vigorously strengthening the awareness and the ability of the staff for risk prevention are all efficient approach for prevention and early warning.

4.1.2 Optimize Contingency Plans Before the Formal Operation of the High-Speed Railway

As an important part of the crisis prevention and early warning, China high-speed railway contingency plans also need improving urgently. Due to the late start of the project, many state-of-the-art technologies must be the introduced from abroad. In addition, our country still have not fully mastered the structure and performance of the CRH trains, if any emergency occurs, lots of problems, such as how to evacuate the passengers, how to disintegrate the CRH train and how to carry out rescue work, cannot be rapidly solved. Therefore, formulating relevant contingency plans for these problems is necessary for emergency management of China high-speed railway. Contingency plans should include scenario descriptions.

The contingency plans should include the assessment of the emergency response resources and capabilities, setting different levels according to the circumstances of the accident, utilizing all kinds of emergency professional rescue organizations and cooperative relations and determining the basic forms of the rescue as well as the rescue capabilities. With the detailed provisions of the plan, training and drills for unexpected emergency accidents must be strengthened.

4.1.3 The Approaches of Emergency Response in the Phase of Operation

In the formal operation of the high-speed railway, emergency management mainly focuses on the day-to-day operations and emergency security incidents. Monitoring the day-to-day operations of the high-speed railway and maintenance for the equipments will help to detect the hidden security risks in the operation of the high-speed railway and prevent the sudden occurrence of safety accidents. However, once safety incidents occur in high-speed rail operation, an emergency command center shall be set up immediately, and emergency response teams shall also be set up both at the station and on the CRH train to carry out emergency rescue and ensure the unified command and action in emergency response. For the emergency incidents that has a sever influence and is beyond the response capability of the railway management, the government shall take the leading position and set up accident rescue command center and a number of teams so as to carry out their respective missions for on-site rescue, accident settlement, medical treatment and information release, etc. Try every effort to eliminate the negative influence of the accident.

4.1.4 The Approaches of Post-crisis Restoration in the Phase of Decommission and Abandon

The tasks in this phase is similar to the phase of design, most detail of approaches will not be discussed again. However, what needs to be emphasized is that the relevant department should make good use of the decommissioned and abandoned high-speed railway equipments and carry out technological innovation and transformation with these equipments so that we may invent new technologies which may be more suitable to the safe operation of the high-speed rail, and that make contribution to the constant improvement of the safety performance of the high-speed rail.

5 Conclusion

In this study, the major risk factors in China high-speed railway is identified from the perspective of the life cycle of China via the risk network theory. Moreover, based on this, the framework for high-speed rail emergency management is raised. The main conclusions of the article are as follows:

Firstly, the main risk factors of China high-speed railway include quality risk, security risk, duration risk and social risk, all of these risk factors are under the influence of the function, structure, equipment, progress, construction organization, security management, technical innovation and other factors of the China high-speed rail project.

Secondly, the emergency management strategies for high-speed railway, according to its life cycle, can be divided into three stages which taking the design and manufacturing stage as an early warning of the crisis, the operation as emergency response disposal, and the decommissioning and abandon stage as recovery and upgrading.

Thirdly, the emergency management of China high-speed railway should focus on crisis early warning in advance to prevent the sudden occurrence of safety accidents. At the stage of crisis early warning, we should emphasize the technical ability, attitude, awareness, physical and mental health of the designers and constructors, we should strictly require the qualifications and job security awareness as well as their knowledge and skill levels for designers and constructors. Meanwhile, we should organize the operations in a scientific manner, implement safety rules and regulations, vigorously strengthen the awareness and capabilities in risk prevention, avoid project duration, quality, safety and other risks and improve crisis early warning. In addition, make urgent improvement to the contingency plans of the high-speed railway, and simultaneously strengthen the emergency response training and drills.

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A Novel Method for Optimal Selection of Technology Commercialization Team Based on Commercial Competence

Ling Zhang and Yi Cui

Abstract Team selection is crucial for the success of technology commercialization. In existing researches on technology commercialization, the technical information is mostly used, while non-technical information is overlooked, especially the information between team members. This paper presents a new method for the optimal selection of technology commercialization team based on commercial competence, in which both technical attributes and cooperative commercialization attributes between team members are concerned. First, an evaluating index system of team selection is proposed, where factors affecting technology commercialization competence are determined. Second, a Fuzzy Evaluation Method for optimal selection of Technology commercialization team is built, and Matlab programs are developed to solve the model. Moreover, an example is used to illustrate the potential application of the proposed method. Results show that the proposed method can enhance theoretical understanding and decision-making for team selection of technology commercialization.

Keywords Commercial competence • Fuzzy evaluation • Technology commercialization • Team selection

1 Introduction

Successful commercialization is crucial in the maintenance of competitive advantage, especially in an increasingly competitive market. Technology commercialization (TC) has drawn the attention of researchers for decades (Chen et al. 2011; Shaker and Anders 2002; Lichtenthaler et al. 2009; Chen 2009; Anokhin et al.

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2011). Moreover, much investment has been committed to the commercialization of new technology recently; however, the commercialization rate is reported to be lower than expected (Sohn and Moon 2003). To increase the efficiency of investment in TC, it is essential to identify appropriate team members, which can directly affect the performance of TC projects (Sohn and Moon 2003). However, little studies have been found to consider the information for TC team selection in details. Moreover, in existing studies on TC, the technical information is mostly used, while the information of commercial competence and team members is neglected. In fact, many advanced TC projects failed in China owing to the lack of technology commercialization competence (TCC) (Lo et al. 2012). As the success of commercialization depends as much on team competence as it does on technical characteristics, team selection is important in the process of TC. By extending previous theories, our study attempts to fill in this gap by proposing a novel model for optimal selection of TC team based on commercial competitiveness, which includes both the technical attributes and cooperative commercialization attributes between team members. The paper also attempts to enhance theoretical understanding and decision-making for the team selection of TC.

2 Literature Review

Some researchers focus on factors that affect the TC performance, such as, interaction with partners (Aarikka-stenroos and Sandberg 2012; Pellikka and Virtanen 2009), trust (Story et al. 2009), collaboration (Story et al. 2009), technical Attributes (Chen et al. 2011; Lo et al. 2012; Maine and Garnsey 2006; Nerkar and Shane 2007), cultures (Dhanara and Parkhe 2006), experiences of the industry (Aarikka-stenroos and Sandberg 2012), support from the university research sector and government (Rasmussen 2008; Link and Scott 2010). Since lots of uncertainty involved in TC (Anokhin et al. 2011), the resources of a single company are rarely sufficient to cover all the requirements of TC, cooperation with other actors is crucial (Pellikka and Virtanen 2009). Some researchers attribute the failure of TC to the lack of commercialization competence. They defined commercialization competence from different aspects, e.g. observation of a firm's competitive environment (Porter 2005), identification of potential risks and opportunities (Lichtenthaler et al. 2009), ability to master or to acquire and integrate the technologies to remain competitive in the markets that they are to compete (Michael Nevens 1990), producing products incorporate an increasing number of technologies to provide more functions to satisfy customers (Chen 2009), the competence to use technologies in products across a wider range of markets, and get products to market faster (Michael Nevens 1990). Whereas these literatures have deeply examined factors that influence the TC, the technology utility is mostly used, while the team information has seldom been a focus. Even though a few studies of innovation network mention commercialization net (Guimera et al. 2005; Feng et al. 2010), they highlights the role of individual in innovation success. It has, by and large, neglected to discuss the impaction of team cooperative attributes on TC. Therefore, a novel perspective should be considered in optimal selection of TC team.

Some other researchers addressed the method for evaluation of partner (Shaker and Anders 2002; Anokhin et al. 2011; Sohn and Moon 2003; Feng et al. 2010). Though they can't be adopted to solve the problem of TC team selection directly, the above literature contributes to our research significantly.

3 Evaluation Index System Based on TCC

An evaluation index system for the optimal selection of TC team is presented in this section, in which both technical attributes and cooperative commercialization attributes are considered. Attributes to measure the two types of utilities for optimal selection of TC team are finalized on the aforementioned literature. The technical attributes include innovative characteristics, R&D experience, technology breadth, application ability, dynamic capability. The cooperative commercialization attributes consist of goal congruence, commercial intelligence, commercialization speed and market expansion. Brief descriptions for these attributes are shown in Tables 1 and 2.

In Tables 1 and 2, all attributes for partner selection are qualitative, so it is convenient for experts to express their opinions using linguistic terms (Chou et al. 2008), therefore, the situation that experts express their opinions using linguistic terms (namely, linguistic labels, such as 'very high', 'high', 'medium') is considered in this study. Furthermore, measurements of the two types of attributes are different due to their characteristics. Measurement of technical attributes is by means of experts' assessment to each candidate partner. Measurement of cooperative commercialization attributes is based on experts' judgment to pair wise partners.

Table 1 Definitions of technical attributes

Index	Definitions
Innovative characteristic	The member can propose a novel technology creatively, which provide a stronger potential to open up new technology domains, establish industry standards and then leverage its rate of diffusion
R&D experiences	The member has research experiences or expertise in a certain field
Technology breadth	The member can master or integrate a number of technologies to provide more functions to satisfy customers
Application ability	The member has the ability to improve the existing manufacturing process/product or to produce a new product, transform invention into innovation and bringing technology to market acceptance and use
Dynamic capability	The member can manage technology development process, reduce costs in technology product development, and improvement in the quality of products

Table 2 Definitions of cooperative commercialization attributes

Index	Definitions
Goal congruence	Team members have the common benefit, congruous value concepts, mutual trust and harmonious personal relations among different organizations
Commercial intelligence	This refers to the extent to which team members can scan and monitor a firm's competitive environment, identify business opportunity and reduce potential risk through cooperation
Commercialization speed	This refers to the extent to which members can initiate, develop, and launch the product to the market in a timely manner, introduce new products more quickly than its competitors through cooperation
Market expansion	Team members have complementary resources that allow them to get strong policy support, market acceptation and larger market share

Table 3 Linguistic terms and corresponding triangular fuzzy numbers

Ratings	Weights	Fuzzy numbers
Definitely low (DL)	Definitely poor (DP)	(0, 0, 0.17)
Very low (VL)	Very poor (VP)	(0, 0.17, 0.33)
Low (L)	Poor (P)	(0.17, 0.33, 0.5)
Medium (M)	Medium (M)	(0.33, 0.5, 0.67)
High (H)	Important (I)	(0.5, 0.67, 0.83)
Very high (VH)	Very important (VI)	(0.67, 0.83, 1)
Definitely high (DL)	Definitely important (DI)	(0.83, 1, 1)

4 Optimal Method for Team Selection

4.1 *Fuzzy Theory*

Fuzzy number is an effective way to deal with the expert evaluation language in decision-making problems. Let $\mathrm{U} = \{\mathrm{u_r} | \mathrm{r} = 0, 1, 2, \ldots, \mathrm{T}\}$ be a pre-established finite and totally ordered linguistic term set with odd cardinalities, where $\mathrm{u_r}$ is the rth linguistic term and presents the words in natural language. Here, we employ a linguistic term set with seven-ranking scale according to real requirements, i.e., $\mathrm{U} = \{\mathrm{u_0} = \mathrm{DL},\ \mathrm{u_1} = \mathrm{VL},\ \mathrm{u_2} = \mathrm{L{:}low},\ \mathrm{u_3} = \mathrm{M},\ \mathrm{u_4} = \mathrm{H},\ \mathrm{u_5} = \mathrm{VH{:}},\ \mathrm{u_6} = \mathrm{DH}\}$. Brief descriptions are shown in Table 3.

A triangular fuzzy number $\widehat{\mathrm{D}}_k$ can be defined as a triplet $\widehat{\mathrm{D}}_k = \left(d_k^L, d_k^M, d_k^R\right)$, where d_k^L, d_k^M and d_k^R are real numbers, $d_k^L \le d_k^M \le d_k^R$. Moreover, to obtain objective equation, we had to convert the final fuzzy data into a crisp value by the converting fuzzy data into crisp scores (CFCS) method (Chou et al. 2008) as follow

$$\mathrm{D}_k^{def} = L + \frac{\Delta\left[\left(d_k^M - L\right)\left(\Delta + d_k^R - d_k^M\right)\left(R - d_k^L\right) + \left(d_k^R - L\right)^2\left(\Delta + d_k^{\mathrm{M}} - d_k^{\mathrm{L}}\right)^2\right]}{\left(\Delta + d_k^{\mathrm{M}} - d_k^{\mathrm{L}}\right)\left(\Delta + d_k^R - d_k^M\right)^2\left(R - d_k^L\right) + \left(d_k^R - L\right)\left(\Delta + d_k^{\mathrm{M}} - d_k^{\mathrm{L}}\right)^2\left(\Delta + d_k^R - d_k^M\right)} \tag{1}$$

Where $L = \min\{d_1^L, d_2^L, \ldots, d_n^L\}$, $\mathrm{R} = \max\{d_1^R, d_2^R, \ldots, d_n^R\}$ and $\Delta = R - L$.

4.2 *Model for TC Team Selection*

Based on the evaluation index system presented in Sect. 3, we propose a fuzzy assessment Method using TCC utility in this section. Firstly, linguistic terms are expressed as triangular fuzzy numbers. Then, the fuzzy numbers are aggregated to obtain the overall assessment value of each candidate partner. Furthermore, the overall assessment values in the form of triangular fuzzy numbers are mapped into the crisp numbers to achieve team optimization model of TC. Details of the proposed approach are presented as follows

4.2.1 Problem Description

Let $\mathrm{P} = \{\mathrm{P}_i | i = 1, \ldots, n; n \geq 2\}$ be a set of n candidate partners, the problem addressed in this paper is to select the most desirable partner(s) from the set P, where P_i is the *ith* candidate. Let $E = \left\{E_f \,\middle|\, \mathsf{f} = 1, \ldots q_f; q_f \geq 2\right\}$ be a set of q_f experts, where E_f is the *fth* expert who is invited by the decision-maker to conduct the partner selection. Here, we suppose that the importance degrees or weights of experts are the same. Let $\mathrm{I} = \left\{\mathrm{I}_j \,|\mathsf{j} = 1, \ldots, m\right\}$ be a set of m indicators, I_j represents the jth attribute. Generally let $\mathrm{I_g} = \{\mathrm{I}_1, \mathrm{I}_2, \ldots, \mathrm{I}_l\}$ and $\mathrm{I}_k = \{\mathrm{I}_{l+1}, \mathrm{I}_{l+2}, \ldots, \mathrm{I}_m\}$ respectively be the set of technical and cooperative commercialization attributes. Suppose $\mathrm{W}_f = \left\{\tilde{\mathrm{W}}_{1f}, \ldots, \tilde{\mathrm{W}}_{mf}\right\}$ be the attribute weight vector provided by expert E_f, where $\tilde{\mathrm{W}}_{gf} = \left\{\tilde{\mathrm{W}}_{1f}, \ldots, \tilde{\mathrm{W}}_{1f}\right\}$ and $\tilde{\mathrm{W}}_{kf} = \left\{\tilde{\mathrm{W}}_{(l+1)f}, \tilde{\mathrm{W}}_{(l+1)f}, \ldots, \tilde{\mathrm{W}}_{mf}\right\}$ respectively are linguistic assessment weights of technical attribute I_g and cooperative commercialization attribute I_k, $\tilde{\mathrm{W}}_{\mathrm{g}f}, \tilde{\mathrm{W}}_{kf} \in \mathrm{U}$.

In this paper, we assume that all experts' assessments on attribute weights, attribute ratings are in the form of linguistic terms. Note $\tilde{x}_{igf}$ as the linguistic assessment of candidate P_i with regard to technical attribute I_g provided by expert E_f, $\tilde{x}_{igl} \in U, i = 1, \ldots, n; \mathsf{g} = 1, \ldots, l; f = 1, \ldots, q_f$. Then the technical attribute ratings provided by expert E_f can be represented by a matrix $\tilde{\mathrm{X}}_{\mathrm{f}}$ as follow

$$\tilde{\mathrm{X}}_{\mathrm{f}} = \left[\tilde{x}_{igf}\right]_{n\times l} = \begin{array}{c} \\ P_1 \\ P_2 \\ \vdots \\ P_n \end{array} \begin{array}{c} \begin{array}{cccc} \mathrm{I}_1 & \mathrm{I}_2 & \cdots & \mathrm{I}_l \end{array} \\ \begin{bmatrix} x_{11f} & x_{12f} & \cdots & x_{1lf} \\ x_{21f} & x_{22f} & \cdots & x_{2lf} \\ \vdots & \vdots & \vdots & \vdots \\ x_{n1f} & x_{n2f} & \cdots & x_{nlf} \end{bmatrix} \end{array}, f = 1, 2, \ldots, q_f \tag{2}$$

Furthermore, the linguistic assessments between candidate partners concerning cooperative commercialization attributes provide by each expert is expressed by a vector $\tilde{Y}_{\mathrm{f}} = \left[\tilde{y}_{ihkf}\right]_{n\times n}$, where $\tilde{y}_{ihkf}$ denotes the judgment on cooperative commercialization utility between candidate P_i and P_h with regard to attribute I_{k} provided by expert E_f, $\tilde{y}_{ihkf} \in U, \mathrm{i}, h = 1, \ldots, n; k = l + 1, l + 2, \ldots m; f = 1, \ldots, q_f$

The cooperative commercialization attribute ratings provided by each expert can be represented by a matrix $\tilde{\mathrm{Y}}_{\mathrm{kf}}$ as follow

$$\tilde{Y}_{\mathrm{kf}} = \left[\tilde{y}_{ihkf}\right]_{n\times n} = \begin{array}{c} \\ P_1 \\ P_2 \\ \vdots \\ P_n \end{array} \begin{array}{c} \begin{array}{cccc} \mathrm{P}_1 & \mathrm{P}_2 & \cdots & \mathrm{P}_{\mathrm{n}} \end{array} \\ \begin{bmatrix} - & y_{12kf} & \cdots & y_{1nkf} \\ y_{21kf} & - & \cdots & y_{2nkf} \\ \vdots & \vdots & \vdots & \vdots \\ y_{n1kf} & y_{n2kf} & \cdots & - \end{bmatrix} \end{array}, \tag{3}$$
$$k = l + 1, \ldots, m; f = 1, 2, \ldots, q_f; k \neq f$$

4.2.2 Assessment of Technology Utility

Firstly, we consider transforming the linguistic terms $\mathrm{U}_r(\mathrm{U}_r \in U)$ into triangular fuzzy numbers by the following formula (Opricovic and Tzeng 2003)

$$\widehat{\mathrm{D}} = \left(d^L, d^M, d^R\right) = \left[\max\left(\frac{r-1}{T}, 0\right), \frac{r}{T}, \min\left(\frac{r+1}{T}, 1\right)\right] \tag{4}$$

where $r = 0, 1, \ldots, 6$.

Now, corresponding relations between linguistic variables and triangular fuzzy numbers can be obtained using (2), as shown in Table 3.

From this $\tilde{\mathrm{W}}_f = \left\{\tilde{\mathrm{W}}_{1f}, \ldots, \tilde{\mathrm{W}}_{mf}\right\}$ can be represented in the form of triangular fuzzy number as $\widehat{\mathrm{W}}_f = \left\{\widehat{\mathrm{W}}_{1f}, \ldots, \widehat{\mathrm{W}}_{mf}\right\}$, where $\widehat{\mathrm{W}}_{jf} = \left(\omega_{jf}^L, \omega_{jf}^{\mathrm{M}}, \omega_{jf}^{\mathrm{R}}\right)$. Then the weight of technical and cooperative commercialization attribute can be in form of $\widehat{\mathrm{W}}_{\mathrm{gf}} = \left\{\widehat{\mathrm{W}}_{1f}, \ldots, \widehat{\mathrm{W}}_{lf}\right\}$ and $\widehat{\mathrm{W}}_{\mathrm{kf}} = \left\{\widehat{\mathrm{W}}_{(l+1)f}, \widehat{\mathrm{W}}_{(l+2)f} \ldots, \widehat{\mathrm{W}}_{mf}\right\}$ respectively.

Likely wise, $\tilde{\mathrm{X}}_{\mathrm{f}} = \left[\tilde{x}_{igf}\right]_{n\times l}$ can be represented in the form of triangular fuzzy number as $\widehat{\mathrm{X}}_{\mathrm{f}} = \left[\widehat{x}_{igf}\right]_{n\times l}$, where $\widehat{x}_{i g \mathrm{f}} = \left(x_{igf}^L, x_{igf}^M, x_{igf}^R\right)$.

Aggregated the linguistic assessment provided by each expert, the collective assessment matrix $\widehat{\mathrm{X}} = \left[\widehat{x}_{i\,\mathrm{g}}\right]_{n\times l}$ is consequently obtained, in which $\widehat{x}_{i\,g}$ is calculated by

$$\widehat{x}_{i\,g} = \left(1\Big/q_f\right) \otimes \left(\widehat{x}_{i\,g1} \oplus \widehat{x}_{i\,g2} \oplus \cdots \oplus \widehat{x}_{igq_f}\right); i = 1, \ldots, n; \mathrm{g} = 1, \ldots, l \quad (5)$$

We note $\widehat{x}_{i\,g} = \left(x_{ig}^L, x_{ig}^M, x_{ig}^R\right)$, then there are

$$x_{ig}^L = \left|\sum_{f=1}^{q_f} x_{igf}^L\right| \Big/ q_f, x_{ig}^M = \left|\sum_{f=1}^{q_f} x_{igf}^M\right| \Big/ q_f, x_{ig}^R = \left|\sum_{f=1}^{q_f} x_{igf}^R\right| \Big/ q_f$$

Using (1), $\widehat{x}_{i\,g}$ is mapped into a crisp number x_{ig} to obtain the ranking value of each candidate partner. Finally the individual evaluation matrix is obtained as $\mathrm{X} = [x_{\mathrm{ig}}]_{n\times l}$.

Through the same processing $\widehat{w}_g$ can be mapped into a crisp number w_g. By simple additive weighting method (Chou et al. 2008), the overall value of members $\mathrm{P_i}$ on technical information can be expressed as:

$$\varphi_i = \sum_{g=1}^{l} w_g x_{ig}, i = 1, \cdots, n \quad (6)$$

The greater φ_i is, the better the corresponding candidate members $\mathrm{P_i}$ will be in the case of only considering the technical information.

According to the overall values of technical information $\varphi_i, \ldots, \varphi_{\mathrm{n}}$, the following optimization model is built to select the most preferred q members from n alternatives

$$\max \mathrm{Z}_1 = \sum_{\mathrm{i}=1}^{\mathrm{n}} \varphi_{\mathrm{i}} x_i, i = 1, \ldots, n \quad (7)$$

$$\text{subject to} \quad \begin{cases} \sum_{\mathrm{i}\in N_h} x_i = q_h, \mathsf{h} = 1, \ldots, c; \quad \text{where} \sum_{h\in 1}^{c} q_h = q \\ x_i \in \{0, 1\}, i = 1, \ldots, n \end{cases} \quad (8)$$

Model (6), (7), and (8) is a simple optimization problem. The optimal solution can be obtained directly by selecting the top q members according to descending order of overall values.

4.2.3 Assessment of Cooperative Commercialization Utility

Let $\tilde{Y}_{\mathrm{f}} = \left[\tilde{y}_{ihkf}\right]_{n\times n}$ be a cooperative decision matrix provided by expert E_f, where $\tilde{y}_{ihkf}$ $(j \neq h)$ is the linguistic assessment between candidate partner $\mathrm{P_i}$ and P_h on index $\mathrm{I_k}$ provided by expert E_f, $\tilde{y}_{ihkf} \in U, i, h = 1, \ldots, n; k = l+1, l+2, \ldots, m; f = 1, 2, \ldots, q_f$.

The decision maker finalizes the cooperative commercialization attribute according to the real requirements of TC team information. We allow nonreciprocal collaboration generally (Opricovic and Tzeng 2003), e.g., member $\mathrm{P_i}$ might give help to member $\mathrm{P_h}$ but not receive help from $\mathrm{P_h}$, i.e., $y_{ihkf} \neq y_{\mathrm{h}ikf}$, and the own information of member $\mathrm{P_i}$ is not considered, i.e., the value of the principle diagonal elements in matrix $\tilde{Y}_{\mathrm{f}} = \left[\tilde{y}_{ihkf}\right]_{n\times n}$ is null.

Using the same procedure on the technical attributes, we can obtain cooperative decision matrix $\mathrm{Y} = [y_{ihk}]_{n\times n}$ and weigh vector w_k. Then the overall value of cooperative commercialization information between members $\mathrm{P_i}$ and P_h can be expressed as

$$\phi_{ih} = \sum_{k=l+1}^{m} \omega_k \mathrm{y}_{ihk}, i, h = 1, \ldots, n, i \neq h \tag{9}$$

The greater ϕ_{ih} is, the better the corresponding candidate members $\mathrm{P_i}$ and P_h will be in the case of only considering the cooperative commercialization information.

According to the overall values of cooperative information ϕ_{ih}, the following optimization model is built to select the most preferred q members from n alternatives.

$$\text{Maximize } \mathrm{Z}_2 = \sum_{\mathrm{i}=1}^{\mathrm{n}} \sum_{h=1, h\neq i}^{n} \phi_{\mathrm{ih}} x_i x_h \tag{10}$$

$$\text{subject to } \begin{cases} \sum\limits_{\mathrm{i}\in N_d} x_i = q_d, \mathsf{d} = 1, \ldots, c; \quad \text{where} \sum\limits_{d\in 1}^{c} q_d = q \\ x_i \in \{0, 1\}, i = 1, \ldots, n \end{cases} \tag{11}$$

4.3 *Optimal Model for TC Team Selection*

To solve the optimal selection problem of TC team, we integrate (6), (7), (8), (9), (10), and (11) to obtain the overall assessment value of each candidate partner. Supposed decision-maker gives weights of the two utilities as ∂ and β, $\partial + \beta = 1$, $0 \leq \partial, \beta \leq 1$ then a comprehensive model is built as follow

$$\text{Maximize} \quad \mathrm{Z} = \partial \mathrm{Z}_1 + \beta \mathrm{Z}_2 = \partial \sum_{\mathrm{i}=1}^{\mathrm{n}} \varphi_{\mathrm{i}} x_i + \beta \sum_{\mathrm{i}=1}^{\mathrm{n}} \sum_{h=1, h \neq i}^{n} \phi_{ih} x_i x_h \tag{12}$$

$$\text{subject to} \quad \begin{cases} \sum_{\mathrm{i} \in N_d} x_i = q_d, \mathrm{d} = 1, \ldots, c; \quad \text{where} \sum_{d \in 1}^{c} q_d = q \\ x_i \in \{0, 1\}, i = 1, \ldots, n \end{cases} \tag{13}$$

5 Application of Proposed Method

In this section, we present an example to illustrate the proposed method in this paper. In forming a TC team, the decision maker adopts five technical attributes and four cooperative commercialization attributes to select four partners from twelve candidate partners, which including government (S_1), enterprises (S_2), college (S_3), research institutes (S_4) and venture capital institutions (S_5). The basic distributions are $S_1 = \{P_1,P_2\}$; $S_2 = \{P_3,P_4,P_5\}$; $S_3 = \{P_6,P_7\}$; $S_4 = \{P_8,P_9\}$; $S_5 = \{P_{10},P_{11},P_{12}\}$; Here the five candidate partners not necessarily mean the individual, it can also be a type of organization.

Supposed four experts in venture capital field were invited to conduct the partner selection task, the importance weights of the five experts are the same. Each expert expresses their opinions on the attributes weights and attributes ratings through a seven-ranking scale linguistic terms as defined in Sect. 3. Using the approach proposed in Sect. 3, weights of technical and cooperative commercialization attributes are obtained as $W_g = (0.67,0.33,0.32,0.32,0.67)^T$, $W_k = (0.41,0.2,0.55,0.59)^T$, the integrated TCC information can be seen in Table 4. In Table 4, the principle diagonal elements are the overall assessment value of each candidate partner on technical utility ($i = 1,2,\ldots,12$), which are obtained by (6), non-principle diagonal elements the overall assessment value of each candidate partner on cooperative commercialization utility, which are obtained by (9).

Assumed $\partial = 0.4$ and $\beta = 0.6$, using (12) and (13), the overall optimal model for team selection based on TCC is obtained as follow

Maximize

$$\begin{aligned} Z = {} & 0.4\,(1.1x_1 + 0.97x_2 + \cdots + 0.97x_{12}) \\ & + 0.6\,(0.7x_1x_2 + 0.97x_2x_1 + \cdots + 0.8x_{11}x_{12} + 0.92x_{12}x_{11}) \end{aligned} \tag{14}$$

subject to

$$x_1 + x_2 = 1 \tag{15}$$

$$x_3 + x_4 + x_5 = 1 \tag{16}$$

Table 4 The integrated TCC information ($\times10^{-1}$)

	P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9	P_{10}	P_{11}	P_{12}
P_1	11	7.0	7.6	8.5	7.2	9.3	8.5	10	11	12.	9.2	8.0
P_2	9.7	9.7	11	8.1	9.9	5.8	9.5	6.3	6.0	11	12	9.8
P_3	9.4	9.0	10	8.4	6.3	8.2	7.7	5.9	8.8	9.0	7.7	9.4
P_4	9.0	9.6	5.4	10	8.9	10	7.1	11	7.0	7.6	8.8	13
P_5	7.2	7.6	6.3	9.8	12	7.6	8.6	11	9.7	5.0	9.2	6.6
P_6	9.8	10.	8.6	7.0	5.3	12	8.4	9.8	8.4	11	5.8	11
P_7	7.5	12	11	10	9.2	7.3	9.5	9.2	7.6	10	12	6.3
P_8	8.4	6.6	9.4	10	9.9	9.6	7.2	13	9.4	8.9	8.5	8.1
P_9	9.4	5.2	9.8	8.1	8.6	7.0	7.1	8.5	9.6	7.0	9.3	11
P_{10}	9.2	6.1	8.7	8.3	9.4	10	8.7	11	6.4	14	7.9	11
P_{11}	9.0	9.6	6.4	7.2	7.9	7.4	8.4	8.7	8.3	9.5	14	8.0
P_{12}	8.2	8.0	10	9.4	8.5	8.0	8.0	4.7	7.0	6.2	9.2	9.7

$$x_6 + x_7 + x_8 = 1 \tag{17}$$

$$x_9 + x_{10} + x_{11} + x_{12} = 1 \tag{18}$$

$$x_i \in \{0, 1\}, i = 1, \ldots, 12$$

To solve (14), (15), (16), (17), and (18), Matlab algorithm is compiled and run on a PC. All solutions are listed for the decision maker to select desired members according to his or her preferences on technical or cooperative commercialization attributes performance. In this case, When Z reaches its maximum value 8.7761, the function solution is (1,0,0,1,0,0,0,1,0,1,0,0), this means P_1, P_4, P_8 and P_{10} are the optimal candidate members for forming a TC team.

6 Conclusion

This paper proposes a method for optimal selection of TC team based on TCC. An evaluation index system of TCC is presented, in which both technology utility and cooperative commercialization utility is considered. A Fuzzy Evaluation Method is introduced to deal with linguistic terms for selecting appropriate team members. In order to solve the model, a Matlab program is employed. Moreover, an example is used to illustrate the proposed method. The main contributions of this paper are as follows.

First, an evaluation index system, including technology and cooperative commercialization utilities, is constructed. A novel idea is presented that the success of TC dependents not only on the advanced technology but also on cooperation between team members. This provided a new research angle of TC in the future.

Second, a Fuzzy Evaluation Method is produced to select the desired member for forming a TC team. The method proposed in this paper is convenient for processing linguistic terms in a fuzzy environment. Moreover, it provides a formal procedure to integrate the technology utility of each member and cooperative commercialization utility between team members.

Third, a Matlab program is compiled to list all the possible results in a computer, which enable decision makers to select appropriate team member under the diversified circumstances and satisfy its requirements.

Moreover, it should be pointed out that team selection of TC is a complicated problem in the real world. Decision makers may prefer to different properties. Therefore, optimal select methods need to be adjusted to the real-world situations.

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Research on Evaluation Theory and System of the Old Industrial Buildings (Group) Recycling Project

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Abstract As a new and important research issue, the old industrial buildings (group) recycling project is currently a relevant and an interesting topic issues researches since 1960s. Especially with the scientific outlook on development, sustainable development, low carbon development concept is hot in nowadays, related research became more active, and the research literature on this topic is vast. Studies this field is more actively in recent years. The current study aims at helping the researchers better by comprehending the existing finds and recently perspectives, we summarized and categorized the findings of research in recent years, and expect to present overall and timely analysis. Literature search shown that most researches were focus on the traditional fields such as function transformation, energy-saving technology application, implementation and management, performance analysis; the emerging fields such as Applied evaluation system and theory of the old industrial buildings (group) recycling project gained more and more attention.

Keywords Evaluation theory • Evaluation system • Old industrial buildings (group)

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1 Introduction

In the complex social environment, all kinds of the building are the human production and life of the substance of the carrier. With the in-depth development of sustainable development process, building material life and function between life of differences, that old building recycle become construction field research hot topic (Hu Ying and Jiang Tao 2010) The old industrial buildings (group) regeneration utilization of city history and characteristics inheritance protection, to build harmonious natural and social environment, reasonable reuse resources and so on many role both building, is the concrete practice of the concept of sustainable development. Because of the old industrial buildings (group) the regeneration of the use of complex causes, constraints, not only strictly, and content various form (Jiang HongYan and Li HuiMin 2008), so that the implementation of showing a very strong case. Although in practice has seen a lot of application example, but whether they realize from technology or management measures, basically all the performance for the project and the state of each different because, has not been formed such guidance of the project implementation theory system. In China's economic construction and urban development course, northeast old industrial base and the northwest region three lines in the construction of a lot of old retained industrial building and reuse is particularly worth attention.

Accurate and reasonable comprehensive evaluation for research object, is not only has the affirmation of the work and the description of the effect, also is the follow-up work direction of the goal and requirements. The old industrial buildings (group) the construction field and recycling of the sustainable development of the practice, the urgent need to a set of system, reflect the activities of the common evaluation system, in order to carry out of the old industrial buildings has (group) recycling conclusion and make objective of prospective recycling project to powerful guidance and support (ZhaoKun 2008).

2 The Present Research Situation and Development Trends

2.1 The Status on Old Industrial Buildings (Group) Regeneration

2.1.1 The Foreign Countries

The old industrial buildings to the diversity of its function change become old building recycling "vane". The first into the industrial society of Europe and the United States and other developed countries and regions, in the 1960s in the scale of the old industrial buildings recycled, and promoting continuously, and accumulated a lot of practice experience, the relevant laws and regulations and policies have been gradually improved management theory, governments have from his early leading management supervisors gradually convert participants, coordinator.

Urban development is a constantly updated and the dynamic process of reconstruction, in this kind of metabolism process, how to deal with the existing of the old industrial buildings is a real problem. The developed countries in the 1960s, from the industrial age to start after the industrial age, urban function change, distribution of industry structure adjustment, the third industry development gradually replace the second industry dominated, lead to the traditional industry gradually decline, the old industrial buildings lose the original function and by many idle. The bulk of the industrial enterprise transformed into a high-tech industry, concentrated in the big old industrial zone have been engineered to high and new industry area, residential area and public activity area, some old plant and its old environment has been converted into homes, stores, new enterprise association and various public buildings (ZhangYanFeng and ChenBoChao 2000).

In 1965, the American landscape master Lawrence Springville, proposed the "building recycling theory". That is different from the simple repair, recycling is the function, the change of adjusting the internal space of the building and be accepted by people. Completed in 1967 years of San Francisco in the square as a comprehensive reform Gillard reflect "recycling" the practice of the theory of product, will have abandoned chocolate factory, scale wool mills, etc for the shop and reconstruction food &beverage facilities, reform, a huge success, with profound effect, thus of a strong old industrial architecture reconstruction was updated boom in the USA (SunFeng 2005).

In the late 1980s with a functional replacement of the way of the old industrial buildings reusing the development model, the transformation of the object for a great deal more industrial revolution in the construction of the factory building and a small amount of heavy industry light industry workshop, the old industrial buildings more improvement in office building, apartment, shops, art galleries, etc. The reform practice also consists of a single individual building of reform of the extended to the whole block updates and transforms (Qiu 2005).

In the 1990s for more than 10 years, the recycling of the old industrial buildings as Europe and the United States architect generally involved in the business, according to the statistics, in the U.S., about 70 % of the project construction and related, 80 % of the buildings in Europe have business belongs to such programs, they in this idea and method has been a fairly high level, accumulated the rich experience, and now many of the western developed countries to the regeneration of the old industrial buildings use has been become old building in the reconstruction of the dominant model.

2.1.2 The Domestic Region

Since the 1990s in China, and increasingly into recycling stage, such as Beijing, Shanghai, Shenyang and Guangzhou, appeared more and more of the old industrial buildings (group) recycling program.

The architect CuiKai will WaiYanShe old enterprise transform for office buildings, yungho chang GuoMian third textile mills old factory building will be updated for the ocean art center, practice, which has carried on the beneficial attempt and exploration. At present, more and more landscape designers and artists join in this field, and artists in Shanghai, suzhou river reforming the old warehouse, make it become the fashionable studio, Peking University landscape design institutes, design of the native Zhongshan park that the former watchword jiang old shipyard in a city beautiful and charming public open space, and access to the American landscape designers association (ASLA) 2002 annual honorary design, especially in the recent years Beijing 798 factory and Shanghai new Oriental's successful transformation, give a person accident surprise and convenient, giving new life to the old industrial buildings, and gradually change the original is desolate, the vitality of the old factory. Even so, but in our country because of the economic, technical and value concept and other factors, in the development of the city in the process of the old industrial buildings still take flattened type development, but also, this kind of phenomenon more and more serious. Popular abroad old industrial buildings of transformation of reusing thinking, in domestic few examples, on a smaller scale, the method is also are not perfect, not perfect theory system (Zhuang Jian 2004).

Xi'an

The 1960s "three line construction" period, to Xi'an are the center of the area is one of the key construction area, realize the intended target, and on the representative. In Xi'an area "three line construction" made great achievements at the same time, there are still many problems, although has been the nearly 20 years of three line enterprise adjustment, but in at present our country to construct the harmonious society in the new period, the question is still very outstanding. Many national defense military enterprise in the move or industrial structure adjustment, idle large industrial building, has not yet made a reasonable effective recycled, need a set of relatively complete theoretical system to guide recycled, thereby better solve three line enterprise after the adjustment legacy. Former Shaanxi steel works of the old industrial buildings recycled to build a complete education park in co-drafted throughout the country.

Shenyang

Known as the "Oriental ruhr," said the shenyang TieXiOu in China on industry has the important position. The district is home to the shenyang boiler general factory, valve factory, plant, nonferrous metallurgy machine rock, and many other large industrial factory area. Twentieth century for China's important mechanical processing base. In recent years, with the industrial structure adjustment and urban function restructuring, the state began the new economic and technology development zone in the planning and construction, over 70 state-owned enterprises to say goodbye to the old factory workshop ingoing. How to deal with the process of old factory building down, be placed in front of people. Shenyang construction engineering college architects through the analyses of the old industrial buildings (group) features and lots of its own cultural potential, and puts forward a series of recycling methods and solutions, and the recycling of the old industrial buildings was attempted.

Beijing

In the new Beijing urban overall plan put forward in “the old city south central axis on both sides of the industry, CangKuOu extension, part of the adjustment for public land for construction”, “the central regions of the factories no longer increases, through the adjustment of land reform walk the road of connotation development, are not suitable for center area development factory, warehouse and construction base and so on facilities in a planned way to transfer out, make land development of the third industry, or other public facilities.” Beijing’s old industrial building recycling with city whole layout on the adjustment. 1993 Beijing dongfeng which makes TV sets of two blocks workshop were rebuilt for office and senior apartment; 1995 Beijing printing workshop for commodity wholesale market in the reconstruction park; In 1999 the Beijing research society enterprise were rebuilt for office buildings; In the 2000 years later, a number of “LOFT” style is given priority to the old industrial buildings in recycling, dashanzi, Beijing 798 factory, 704 factory areas, the old industrial building recycling has made the exploration.

Shanghai

The 1990s with a number of pollution factory moved to qingpu, baoshan, remote area, Shanghai industrial center of gravity to emerging industrial zone with suburban or transfer, large municipal facilities also began to expand outside. Shanghai chemical fiber four factory, USES the original plant characteristics, through the rebuilding, add layer and so on many kinds of method, a common industrial plant reconstructed to a modern business center; Shanghai nine factories will one spinning workshop rent to guangdong red ZiJi food company, transformed into Shanghai red ZiJi gourmet center for good economic benefit. In the 2000 years, suzhou river of the old industrial buildings and storage of competing to become an artist and designers to rent of studio, make more people aware of the twentieth century important heritage’s value.

Our country at present the old industrial building recycling show the following two characteristic transformation: build project focus on Beijing, Shanghai and other economic developed city, this is our country economic development is not balanced reflect, believe that with other parts of the economy development and people to raise the level of understanding, recycling program will be more and more;

Reconstruction project in a large proportion is transformed into an artist studio or building design, media is made, advertising planning, creative industry work, a single comparison function.

In addition, the domestic old industrial building recycling scale general not big, many for single building structures, and also have individual involving the whole factory transformation. At the same time, the transformation of industrial building more for light industry workshop, such as which makes TV sets, watches and clocks, factory, textile, printing, etc.; And the use of recycled after general for catering, entertainment, business and office place, etc. Already the regeneration of the implementation of the main distribution project in Shanghai, Beijing, Shenyang and Harbin, chengdu, xi'an and so on big and medium cities and urban these rich industrial foundation, and city construction pace faster, the contradiction between the adjustment of industrial structure, so the old industrial building recycling practice also from spontaneous behavior gradually standard planning and management, as the old industrial buildings (group) recycling pilot city (Liu WeiHui and Zhang jian 2007). Reuse of old industrial building already is the important content in the field of construction shall, according to the natural characteristics of developing a corresponding theoretical research, this study was to evaluate the theory of when one of them.

2.2 The Recycled Evaluation System of Old Industrial Buildings (Group)

The old industrial buildings (group) recycling universal existence are widely accepted and that it has become an important part of the construction field, but also the sustainable development of the important practice in this field. Thus around the old industrial buildings (group) recycling project experts at home and abroad from several aspects of scholars, planning and design, architecture design, function transformation, energy saving technology use, implementation management, performance analysis, the research content has set up a file in the current of all kinds of literature retrieval can reflect, but according to the old industrial buildings (group) recycling project evaluation theory but few studies, and just in the transformation of the old buildings in the field of general involved with the evaluation system research (Liu ChenYang 2010).

About the old industrial buildings (group) recycled evaluation theory research and lack of basic data first there is a definite link between lack of statistics. Every Chinese big industrial zone has been completed a lot of old industrial buildings (group) recycling project, but there is still no including all kinds of industrial architecture form, and the recycling of a complete basic data and statistics, this become inhibition of the old industrial buildings (group) and recycling of the theoretical study of evaluation bottleneck. Next to the selection of evaluation methods at present relatively old, the evaluation process needs a large number of acquisition experts to the various index quantification scores, and subjective evaluation results from serious influence factors, and the new method for innovation to implement.

2.3 Project Evaluation Theory and Its Development

For many kinds of project evaluation theory, from the evaluation phase view, has decision-making before evaluation, implementation evaluation; From the content of assessment and the nature of it, there are economic evaluation and social evaluation, environmental assessment, etc. The current in the construction field, with the basic evaluation theory for support, based on the concept of sustainable development, based on the “green building”, have each has its own national characteristics of the building evaluation system. Foreign basically has the United States LEED green building assessment system, British BREEAM system, Japan’s CASBEE system, Canada, Australia NABERS GBC system of system, Norway’s Eco Profile system, French ESCALE system, etc.; And our country also in June 1, 2006 promulgated the “green building evaluation standard”, “China’s Olympic construction assessment system” study is another research branch.

3 The Old Industrial Buildings in Our Country and Recycling of Application Prospect

For our country to, in recent years due to the adjustment of the industry and other reasons, the state-owned enterprise especially large state-owned enterprise production, bankruptcy, go out of business situation many, many and caused a lot of industrial plant and equipment idle, freeze funds, laid-off workers, unemployment; Because our country industry structure adjustment and the development of city scale, and the western area of the “third line” enterprise into a new period of adjustment. With shaanxi province of the nearly 500 a “third line” enterprise as an example, except some enterprise through the industry adjust the smooth transition, there are quite a number of enterprises face of production, the move of bankruptcy, collapse, this has caused a lot of industrial architecture (group) the idle (Ma 2003). Our country the emerging of the old industrial buildings (group) large number of idle and abandoned problem, and the current situation of urban construction and economic system change closely linked. Because of our country’s old industrial buildings (group) in former construction are common when scattered layout messy, land use high proportion, geographical advantages, such as environmental pollution problems, thus become urban renewal transformation and clean up urgently needed in one of the main object. If can revitalize, use these enterprise of the plant and equipment, to improve efficiency, and will no doubt increase played a positive role in the national income. We can use this part of the rich, the cheap labor, also can use the ready-made idle industrial workshop, seize the opportunity, rapid transformation put into production, and soon returns. In addition, with the development of the city and the enhancement of the people environmental protection consciousness, many at the city center factory have moved or transformation and a large number of empty industrial workshops need modification or removed, in order to adapt to the change of use function (the original industrialization to change). And removal than new, recycling have obvious advantages, main performance in the following aspects: setting up approval formalities simplified; Construction cost is low; Construction period is short; Covers an area of area was not affected by for redesign; Normal use can maximum limit to safeguard (Male Seashells and Lin ShaoBo 2003).

The old industrial building mainly for industrial workshop, the classification in the form of the structure, main can be divided into single plant and multi-layer workshop; According to the material classification mainly divided into steel reinforced concrete structure workshop and steel structure plant. At present the vacancy factory located in the city is mostly reinforced concrete building. Due to the original plans economy and the standard design, this kind of plant type basic similar, namely single-layer reinforced concrete structure and multilayer reinforced concrete bent assembly integral structure. This kind of plant regeneration use has the following advantages:

(a) Internal plant a large space, easy to use full transformation. The span of factory building is generally 12 m, 18 m or more big, column for 6 m from general or 8 m, this makes the renovation of the plant a lot of creative space. If can will plant transformation for large supermarket, stores, hotels, clubs, teaching building, office building, exhibition hall, etc.
(b) Building structural simplicity is common, facilitate safe and reliable to reform. Such as single plant often is the typical single-layer single span or single across more bent structure, multilayer workshop is often multilayer reinforced concrete assembly integral frame structure. This kind of structure flat facade rules, power transmission line is clear, the node stress and clear, for structural modification provided the necessary prerequisite.
(c) The strength of the stress components factory and bearing capacity is good. Because this kind of plant most used precast concrete component, such as the bent frame column, prefabricated basket and precast prestressed beams prefabricated porous plate, shaped groove plate, F shape board, component production quality is better and had used in industrial production, so its bearing capacity is bigger, can generally meet current civil building use requirement.
(d) Plant generally higher, can make full use of the layer through has the obvious economic benefits.
(e) The external walls of the workshop is generally around the wall, can according to the transformation to dismantle heavy build by laying bricks or stones or directly use.

The old industrial buildings of the state-owned enterprise (group) is to save energy recycling, and reducing environmental pollution and effective use of resources concrete manifestation, embodies the sustainable development and the construction of the country put forward the spirit of economical society. In addition, enterprise restructuring is undoubtedly the smooth the current our country to construct the harmonious society's important component, if can make full use of these enterprise of unused regeneration of the old industrial buildings, would be certain to driving regional economy, increase the social benefit, improving national income has positive and important role. Therefore, the old industrial buildings (group) recycling have considerable social benefits and economic benefits.

4 Conclusion

Reuse of old industrial building is sustainable development in the field of construction to reflect. But the comparative analysis of the standard, it is known that the existing evaluation system on newly-built building more, a touch of old buildings, but few see specific at the old industrial buildings. Therefore, there is an urgent need for the old industrial buildings (group) recycling project based on the sustainable development theory, the evaluation idea, the evaluation process, and the evaluation method as well as the feasibility of the pioneering stage, multi-level and open more evaluation system, in order to guide the work of the actual propulsion.

The old industrial buildings (group) and recycling of the establishment of evaluation system, not only can guide and inspection of the old industrial buildings (group) recycled activities, but also for the whole market with restriction and standard, it can guide the old industrial buildings (group) recycling project to health, standard track development. The research results to practical work of the guidance, the basis of the old industrial buildings in our country (group) recycled promising a particularly important at this stage of the practical significance; At the same time, the evaluation system is established to project evaluation theory of complement and perfect, has a positive theoretical significance.

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Eco-budget Study of China Main Functional Areas

Wen-ming Sun, Li-ping Xu, and Li-li Wang

Abstract To promote the construction of ecological civilization and the development of main functional areas in China, the government holds to strengthen the main functional areas for public services and the ecological environment compensation financial transfer payment, making local residents to enjoy the equalization of basic public services. But how to build the ecological compensation mechanism of main functional areas, how to use the ecological environment compensation financial transfer payment effectively, it has not yet made specific plans. Therefore, the main functional areas in China should implement eco-budget management, making ecological transfer payments and ecological compensation funds included in the eco-budget management of the main functional areas.

Keywords Eco-budget • Ecological compensation • Ecological transfer payment • Main functional areas

1 Introduction

To strengthen the system construction of the ecological civilization in China, this paper studies the main function areas financial transfer payment, recommending for using eco-budget management methods.

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2 Foreign Economic Areas Ecological Compensation Management

2.1 Ecological Compensation of Foreign Economic Areas

Foreign economic areas are roughly divided into expansion area, development area, restricted area and protected area (Liu Yi-cheng and Chang Yan 2010), which is similar to the main functional areas in China. In recent years, the ecological compensation of foreign economic areas is understood as paying for environmental service (PES) (Farley and Costanza 2010). Relative to the traditional command control policy instruments, direct payments for ecological services is considered to be a relatively effective measure (Kemkes et al. 2010). PES is built directly on the basis of the Coase theorem.

2.2 Economic Theoretical Basis of the Regional Ecological Compensation

Solow pointed out that environmental economics is the use of the economic theory of externalities (Solow 1956). The externality theory we studied is the basic theory of the ecological compensation mechanism. From an economic sense, the space flow, characteristics of ecosystem services and the complexity of the ecosystem services provide externalities. If administrative jurisdictions coincide with the circulation space of ecological services, the responsibilities of the ecological services provided by the local government would implement the provision of ecological services. Ecological services circulation space beyond the boundaries of the administrative area needs different jurisdictions government cooperation (Engel et al. 2008). Therefore, if a jurisdiction implemented ecosystem conservation and restoration activities are not only the external characteristics of the region, it contains the characteristics of the inter-district externalities at the moment.

2.3 Regional Ecological Compensation Practice

Foreign practice of ecological compensation could be divided into the government as the only compensation, the main government-led and market-oriented operation of three modes (Norén and von Malmborg 2004). The government-led could be divided into direct compensation, the system of ecological compensation fund, the ecological compensation tax, regional transfer payments and regional cooperation. Market-oriented operation could be divided into green reimburse quota trading, eco-labeling system, emissions permit trading and international carbon trading.

Much of ecological compensation funds in developed countries are billed by the government, such as the United States and Germany. The United States chooses to purchase by the government of national forest ecological benefits, providing ecological compensation funds to improve the eco-efficiency (Ammenberg et al. 2001). After consideration by Parliament, the financial allocation, the German ecological compensation funds mainly by horizontal transfer payment to achieve inter-regional equalization. There is a complex set of calculations to determine the transfer standard payment amount in German.

3 Main Functional Areas of Eco-budget in China

3.1 Literature Review of Domestic and International Eco-budget

As early as in 1987, Konrad Otto-Zimmermann, an ICIEI (International Council of Local Environmental Initiatives) European district governing administrator, pointed out a technical mean which could collect and process environmental data to make human ecology resource management as the management of financial resources effectively (Otto-Zimmermann 2002). The eco-budget can make up for the traditional environmental issues of economic considerations, and be considered as an ecological management measure. Eco-budget is used to guide an organization, implementation, and assessment of the environmental management framework, this model is based on the Deming PDCA-cycle (plan, Do, Check, Act) concept (Chenhall 2003).

Domestic HAO Wei-xia researched the eco-budget management measure, introducing the European eco-budget in city (Hao Wei-xia and Teng Li 2010). In recent years, HU Wei argued that the eco-budget could be included in the budget process, the ecological cost as a starting point, the proposed implementation of the strategy-oriented enterprise budgeting model (Carey 1993). XU Li-ping based on stakeholder perspective of the ecological value, recommended the establishment of eco-budget independent budget (Xu Li-ping and Wang Xiong-wu 2010). We can find the above research and our eco-budget process and explore the practical operability.

3.2 The Necessity of the Eco-budget Management in Main Functional Areas

The primary means of our current ecological compensation is government transfer payments, but the ecological transfer payment system is not perfect (Yu Peng et al. 2009). The provincial fiscal transfer system is not sound enough, at the same time, we promote our ecological functional area transfer payment method is still in its infancy, lacking of full and effective participation of the relevant stakeholders. Regions are combined with relevant policies and systems to carry out the function of ecological planning. On the one hand, to achieve ecological function areas transfers goal, we must learn from foreign advanced theoretical and empirical scientific measure to manage the ecological environment in the main functional areas. On the other hand, there are different ecological budgetary practices of Western countries or regions. It could not be directly copied to the application in practice of the ecological compensation management in China. Ecological function transfer payment don't definitely divide the line as to how to pay, part of compensate funds is been used for basic and public service. The rest part is to support ecosystem construction and environmental protection. Both of them lack explicit demarcation. The latter part will run out on a bank in the function bottom of local government right, therefore, the eco-budget can help the production and construction funds to separate from the compensate funds and to ascertain compensate object so as to raise compensate funds use efficiency more definitely.

4 Main Functional Areas Eco-budgeting

4.1 The Main Functional Areas Eco-budgeting

The main functional areas of local government can use the SWOT analysis method, a comprehensive analysis of the internal strengths and weaknesses of the functional areas, external opportunities and challenges, to find a suitable local function eco-budget management method. First, the implementation and analysis of the eco-budget for the year is expected to the basis for the preparation of next year eco-budget. Make comparative analysis according to eco-budget revenues and expenditures combined with the trend of economic development. Secondly, local government needs draft the second half annual ecosystem budget receipt and expenditure index. Before formal budgeting, the Ministry of Finance also intended eco-budget revenue and expenditure indicators as the basis of the preparation of various localities and department eco-budget. Eco-budget revenue and expenditure indicators should be based on the various departments, to discuss what resources and environmental issues should be included in the budget and woven into the index system as a whole. Then the implementation team prepare overall budget framework table according to budget summary of various indicators.

The eco-budget revenue and expenditure targets should be connected with economic index which is determined by the state planning commission. We need to seek for the local opinions through national planning meeting when eco-budget indicators have been prepared, making a final and specific estimate at last. The public organizations resource allocation process is a series of continuous decomposition, overlapping and fragmentary, but it is characterized by mutual contact, parallel decision-making sequence. A core value of the budget management is to control the distribution of power (Rubin 1990). Therefore, we start from both vertical and horizontal in the analysis of the main functional areas eco-budget preparation process.

4.2 The Main Functional Areas Eco-budgeting Phase

Eco-budget is built on the basic budget theory and processes including the micro level of the bottom-up and top-down macro-level, the former is limited and the latter is a comprehensive management process (O'Neill 2004). Balance of micro and macro levels make budget management more long-term.

First of all, the provincial and central departments put forward annual eco-budget proposal data then submit them to the Ministry of Finance. The Ministry of Finance develops eco-budget control index and issue after approved by the State Council issued according to the plan for national economic indicators and the number of reported suggests. The province and central departments layout and assemble the preparation of eco-budget of the area and the units when approved by the provincial government or the central competent departments for examination. They will be finally assembled into the State Council review the draft state budget after the summary reports have been sent to the Ministry of Finance. We need to write eco-budget when prepare eco-budget draft. Ministry of Finance will inspect the central and local eco-budget draft and then build up them into eco-budget draft and later will sent to the plenary session of National People's Congress and ask for approval.

4.3 The Main Functional Areas Eco-budget Report Phase

According to the constitution, the National People's Congress has right to review and approval of the national budget and the report the implementation of the budget. After the approval formalities, ecol-budget proposal financial become the legally building state budget. The local government eco-budget is the basis. The governments at all levels should be responsible for it. The National People's Congress approval formalities to perform the procedure:

1. *Prepare work before review*: The financial and economic committee of the National People's Congress listen to the plans for national economic and social development project implementation, the eco-budget implementation report of the local ecological main function areas based on the lateral transfer payment report to the Ministry of Finance. National bureau of statistics state environmental protection department is introduced about the ecological economic protection and the annual work plan progress.
2. *The state council and the meeting report show to the National People's Congress*: The Ministry of Finance influences on the following reports and documents:

eco-budget and performance report about main function areas based on the lateral transfer payment reporting. The national economic and social development plans and project performance report plans for national economic and social development main index in main function areas where the lateral transfer payment.

3. *National People's Congress for deliberation and approval*: The delegation of the report and related material review, finance committee should be responsible for the corresponding to the presidium of the audit report. The report of the presidium, deliberation by the plenary session, eco-budget proposal is to be a legally binding formal document after the vote passed.

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Measurement Model of Project Risks of Commercial Banks Based on Combination Weighting

Zhan-jiang Li, Guo-tai Chi, and Zhan-dong Xu

Abstract How to utilize the limited risk information to measure the project risk is an urgent problem to be solved when commercial banks do not have the ability to master all specific information of the project. This paper uses five risk elements including government risk, industry risk, policy risk, investment risk and credit risk to reflect the project risk, and constructs measure model of the project risk when the commercial banks can not fully grasp the project information. The characteristic of this paper is to use combination weighting based on G1 and Maximizing Deviation method to measure the important degree of risk elements, further to solve measure problem of business project risks in the case of the limited project information. The results show that the important degree of the project risk is listed in descending order: government risk, investment risk, credit risk, policy risk, industry risk.

Keywords Combination weighting • G1 • Maximizing deviation • Project risk • Risk elements

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1 Introduction

The measurement of project risks is an important content of risk management of commercial banks. If commercial banks are ready to invest in an enterprise project, it has to measure the project risk. When commercial banks grasp the full project information, a large number of researches have been done. But in many cases banks do not have the ability to master all specific information of the project. Therefore, How to take advantage of the limited risk information to measure the project risk is an urgent problem to be solved when commercial banks can not fully grasp the project information.

The existing research about project risk measurement of commercial banks has the following aspects. Moody's analyzes risk elements of the project risk and believes that project risk should include policy risk, operational risk, market risk and other risk factors in research report (Moody's 2003). Stand & poor's believes that the industry risk, investment risk and credit risk are important impact elements of project risks in research report (Poor's 2008). Christa Hainz and Stefanie Kleimeier analyze the impact of political risk on project finance in syndicated lending (Hainz and Kleimeier 2012). Zheng Chao studies the risk of mergers and acquisitions loan projects and establishes index system of risk controls including operational and financial risk, strategic risk, and integration risk (Zheng Chao 2012). Fu Miao and Tan Xiaobo studies the environmental risk factors of commercial bank credit project and establishes assessment model according to the environmental risk preferences of the different bank (Fu Miao and Tan Xiaobo 2011). A. Ulucan uses data envelopment analysis to study social risk efficiency of bank projects (Ulucan and Atıcı 2010). Chao Fang and Franck Marle use decision support system to establish model of project risks and risk interactions (Chao Fang and Franck Marle 2012). Arazi Idrus, Muhd Fadhil Nuruddin and M. Arif Rohman use fuzzy expert system to estimate project risks (Idrus et al. 2011). Tomoichi Sato and Masahiko Hirao study the trade-off problem of project budgets and critical risks (Sato and Hirao 2013). Prasanta Kumar Dey establishes integrated framework for managing project risks (Dey 2010). S. M. Mousavi et al use non-parametric resampling to research engineering project risks (Mousavi et al. 2011).

The major problems of the existing research are lacking of measure research about the project risk when commercial banks can not fully grasp specific information of the project such as financial Information.

This paper uses five risk elements including government risk, industry risk, policy risk, investment risk and credit risk reflecting project risk. Moreover, the paper constructs measurement model of project risks based on optimal combination weighting of G1 method and Maximizing Deviation method and solves measurement problem of business project risks when the commercial banks can not fully grasp the project information.

2 Risk Elements Analysis and Its Scoring

2.1 The Government Risk Analysis and Its Scoring

Different government support will lead to different project risk, and government support has an important influence on the project risk (Moody's 2003; Poor's 2008). The government risk R_1 reflects the project risk due to different government support.

Therefore, the research group selects government support indicator to reflect government risk R_1, further to reflect project risk R_P. Business project can be divided into five categories according to the descending order of government efforts to support the enterprise project. The five categories include national key projects, provincial key projects, municipal key projects, county key project, and other projects.

So project categories are shown in column 1 of Table 1 and government support in descending order is shown in column 2 of Table 1. By way of Delphi method, values of government risk R_1 are shown in column 3 of Table 1.

2.2 The Industry Risk Analysis and Its Scoring

The industry climate index reflects the project's future earnings prospects, and it is an important factor of affecting the project risk (Moody's 2003; Poor's 2008). Therefore, the research group selects industry climate index indicator to reflect industry risk R_2.

Because of time lag of obtaining the industry climate index, the research group uses the predictive value of the business climate index to measure the industry risk R_2 based on the PERT (Program Evaluation and Review Technique) forecast method.

According to the business climate index published by China National Statistics Bureau, predicted values of the business climate index are shown in row 1 of Table 2. By row 1 of Table 2, the industry risk R_2 is shown in row 2 of Table 2 through scoring formula (1) for negative index. Let x_i denote the ith predicted values of the business climate index. Then scoring formula for R_2:

Table 1 Government risk r_1

Serial number	(1) Project categories	(2) Government support	(3) R_1
1	National key projects	Largest	1.0
2	Provincial key projects	Larger	1.1
3	Municipal key projects	Large	1.2
4	County key project	Small	1.3
5	Other projects	Smallest	1.5

Table 2 Industry risk r_2

(1) Index	(2) Overall	...	(10) Accommodation and catering
Climate index forecast	129.730	...	104.640
Industry risk R_2	1.236	...	1.500

Table 3 Policy risk r_3

(1) Industry classification	(2) R_3
The first industry: restricted and eliminated industry	1.5
The second industry: encouraged industry	1.0
The third industry: other industry	1.2

$$R_2 = \frac{\max(x_i) - x_i}{\max(x_i) - \min(x_i)} \times 0.5 + 1 \tag{1}$$

The result of formula (1) scoring is that range of R_2 becomes [1,1.5]. The basis of selecting [1,1.5] as standardized intervals lies on: intervals [1,1.5] only change standardized value of risk variables, does not change order relationship of the risk coefficient, and solve the problem that quantitative weighted methods does not work in [0, 1] interval when values of risk variable are 0.

2.3 The Policy Risk Analysis and Its Scoring

Policy-oriented of different industries will lead to different project risk, and it has an important influence on the project risk (Moody's 2003; Poor's 2008). The policy risk R_3 reflects the project risk due to different policy-oriented. Therefore, the research group selects industry policy-oriented indicator to reflect policy risk R_3, further to reflect project risk R_P.

Based on "industry restructuring Catalog" published in 2005 by the National Development and Reform Commission of China, the industry is divided into three categories and the results are shown in column 1of Table 3. According to Delphi method, values of R_3 are shown in column 2 of Table 3.

2.4 The Investment Risk Analysis and Its Scoring

The different investment amount of commercial banks will lead to the different project risk (Moody's 2003; Poor's 2008). The investment risk R_4 reflects the different projects risk due to the different investment amount. The greater investment amount of the invested project will lead to the larger investment losses and investment risk if the risk occurs.

According to the provision of China Commercial Banking Law, the maximum value of the project investment is defined as 10 % of the capital balance of

Table 4 Credit risk r_5

Sequence	(1) Business credit rating	(2) Credit risk R_5
1	Central government	1.000
2	AAA level business	1.042
3	Provincial government	1.083
4	AA level business	1.125
5	Municipal government	1.167
6	County government	1.208
...	...	...
12	CC level business	1.458
13	C level business	1.500

commercial banks, and the minimum value of the project investment is 0. By the actual investment amount of the project, the investment risk R_4 can be calculated through scoring formula (2) for positive index.

Let y_j denote the actual investment amount of the project. Then scoring formula for R_4:

$$R_4 = \frac{x_i - \min(x_i)}{\max(x_i) - \min(x_i)} \times 0.5 + 1 \tag{2}$$

2.5 The Credit Risk Analysis and Its Scoring

The different credit rating of business which project belongs to will lead to different project risk, and business credit rating has an important influence on the project risk (Moody's 2003; Poor's 2008). The credit risk R_5 reflects the different project risk due to different credit rating of the business. Therefore, the research group selects business credit rating indicator to reflect credit risk R_5, further to reflect project risk R_P.

According to Delphi method, business credit ratings in descending orders are shown in column 1 of Table 4. The highest business credit rating is central government and its credit risk score is determined for 1. Moreover, the lowest business credit rating is C grade enterprise and its credit risk score is determined for 1.5. Based on grade difference method, the credit risk value interval [1, 1.5] is individed into 12 equally. Credit risk scores of each credit rating are shown in column 2 of Table 4.

2.6 Measurement Equation of Project Risks

In order to measure the project risk, measurement equation of project risk R_P can be defined in (3):

$$R_p = \sum_{i=1}^{5} w_i R_i \tag{3}$$

The economic meaning of formula (3): the project risk R_P equals to weighted portfolio of the five risk elements including government risk, industry risk, policy risk, investment risk and credit risk, in which w_i is the standardized weight coefficient to meet $w_1 + \cdots + w_5 = 1$ and $w_i > 0$.

3 Weights of Risk Elements

3.1 Weight of R_1, R_2, R_3

Combining expert experience and objective reality, we use combination weighting of G1 method and Maximizing Deviation method to determine weight a_1, a_2, a_3 of government risk R_1, industry risk R_2, policy risk R_3.

3.1.1 Subjective Weighting of G1 Method

Let u_j denote G1 weight of the ith risk element, h_i denote the rational assignment given by the risk experts, m denote the number of indicators. Calculation steps of weight u_i as follows.

(a) Use G1 method to determine the order relationship of risk elements.
(b) Experts give rational assignment h_i that denotes the ratio of the importance degree of the risk element $R_{i\text{-}1}$ and R_i.
(c) According to rational assignment h_i, G1 method weight u_m of the mth risk element can be defined in (4) (Zhang Yi and Wang Xianjia 2012; Chi Guotai et al. 2008):

$$u_m = \left(1 + \sum_{k=2}^{n} \prod_{i=k}^{n} h_i\right)^{-1} \tag{4}$$

(d) Depending on weight u_m, G1 method weight of the other risk element can be defined in (5) (Zhang Yi and Wang Xianjia 2012; Chi Guotai et al. 2008):

$$u_{i-1} = h_i u_i,\ i = m,\ m-1, \ldots, 2 \tag{5}$$

3.1.2 Objective Weighting of Maximizing Deviation Method

Let v_i denote Maximizing Deviation method weight of the ith risk element, r_{ij} denote the jth sample value and the ith risk element, r_{ik} denote the kth sample value and the

ith risk element, n denote the sample size. The calculation formula of weight v_i can be defined in (6) (Gui-Wu Wei 2008; Huo Liangan and Wang Zhongxing 2012):

$$v_i = \frac{\sum_{j=1}^{n}\sum_{k=1}^{n}\left|r_{ij} - r_{ik}\right|}{\sum_{i=1}^{m}\sum_{j=1}^{n}\sum_{k=1}^{n}\left|r_{ij} - r_{ik}\right|} \tag{6}$$

3.1.3 Combination Weighting

Let a_k denote the combination weight of the kth risk element. Based on the principle of the minimum sum of squared deviations, an optimization model can be defined in (7)–(8):

$$\min \sum_{k=1}^{m}\left\{(a_k - u_k)^2 + (a_k - v_k)^2\right\} \tag{7}$$

$$s.\ t.\ \sum_{k=1}^{m} a_k = 1 \tag{8}$$

We make use of Lagrange multiplier method to solve the optimization model including objective function (7) and constraint condition (8). At last, the unique solution of combination weights a_k can be defined in (9) (Guo Yajun 2007):

$$a_k = \frac{1}{2}(u_k + v_k) \tag{9}$$

The features of combination weighting method are to reflect the change of the indicator data and experience of experts, to embody the unity of the subjective understanding and the objective data.

3.2 Weight of R_4, R_5

It should be noted that:

1. The investment risk R_4 only relies on the investment amount of the current project investment behavior and the credit risk R_5 only relies on the credit rating of subordinate business of the current projects. Therefore, the investment risk value and credit risk value can only affect the project risk value, and can not affect their weight.

2. In the public information, we cannot get the appropriate information to obtain the historical sample data of investment risk and credit risk.

With regard to the investment risk R_4 and credit risk R_5 of the lack of data, we use intermediate interpolation method to measure their weights.

Employing Delphi method to make questionnaire survey for risk management experts from universities and banks, we can obtain importance degree of the risk elements in descending order:

Government risk $R_1 >$ Investment risk $R_4 >$ Credit risk $R_5 >$ Policy risk $R_3 >$ Industry risk R_2.

In accordance with the above sequence of risk elements, we can obtain importance degree of the weight in descending order:

$a_1 > a_4 > a_5 > a_3 > a_2$

According to intermediate interpolation method, the formula of weight a_4, a_5 can be defined in (10) and (11):

$$a_4 = a_1 - (a_1 - a_3)/3 \tag{10}$$

$$a_5 = a_1 - 2(a_1 - a_3)/3 \tag{11}$$

3.3 Standardization Weights

The formula of weight w_k can be defined in (12):

$$w_k = a_k / \sum_{k=1}^{5} a_k \tag{12}$$

Standardization weight w_k of the formula (12) is final weight of project risk measurement model (3).

4 Establishment of Measure Models

4.1 Project Data

Project information including project name, government support of project, and the subordinate industry of the project, policy-oriented of industry comes from the following sources: People (http://www.people.com.cn) and Netease finance (http://www.money.163.com). According to People and Netease finance, the information of 72 loan projects is shown in column 1–4 of Table 5.

Table 5 Project data

Serial number	(1) Project name	(2) Government support	(3) Industry	(4) Policy-oriented	(5) R_1	(6) R_2	(7) R_3
1	Shanghai rail engineering	Provincial key projects	Transportation	The third category	1.1	1.377	1.2
…	…	…	…	…	…	…	…
72	Wujiang and Taihu control	County key projects	Total	The second category	1.3	1.236	1.0

If the project involves two industries, the subordinate industry of the project will be defined as the overall industry. According to the government support information in column 2 of Table 5, look up risk values shown in column 3 of Table 1 and obtain R_1 listed in column 5 of Table 5. According to the industry information of 72 projects in column 3 of Table 5, look up risk values shown in row 2 of Table 5 and obtain R_2 listed in column 6 of Table 5. According to the industry policy-oriented information of projects in column 4 of Table 5, look up risk values shown in column 2 of Table 3 and obtain R_3 listed in column 7 of Table 5. It should be noted that: the investment risk R_4 and credit risk R_5 are not been measured. The reason is shown in the above section.

4.2 Calculating Weights

According to expert opinion, the sequence of the risk elements is shown in descending order:

Government risk $R_1 >$ Investment risk $R_4 >$ Credit risk $R_5 >$ Policy risk $R_3 >$ Industry risk R_2

Because investment risk R_4 and credit risk R_5 are short of data, the sequence of the risk elements which can obtain data is shown in descending order:

Government risk $R_1 >$ Policy risk $R_3 >$ Industry risk R_2

The rational assignment of expert opinion is shown: $h_2 = R_1/R_3 = 1.5$, $h_3 = R_3/R_2 = 1.5$

According to the above rational assignment, use formula (4)–(5) to obtain weight u_2, u_3, u_1. The results of weight u_2, u_3, u_1 are shown in column 2 of Table 6.

According to Maximizing Deviation method, use formula (6) to obtain weight v_1, v_2, v_3. The results of weight v_1, v_2, v_3 are shown in column 3 of Table 6.

Table 6 Weights of risk elements

Serial number	(1) Risk elements	(2) u	(3) v	(4) a	(5) w
1	R_1	0.474	0.491	0.482	0.268
2	R_2	0.210	0.185	0.198	0.109
3	R_3	0.316	0.324	0.320	0.177
4	R_4	–	–	0.428	0.238
5	R_5	–	–	0.374	0.208

According to the optimization model (7)–(8) of combination weighting, use the unique solution formula (9) to obtain combination weight a_1, a_2, a_3. The results of weight a_1, a_2, a_3 are shown in column 4 of Table 6.

According to intermediate interpolation method, use formula (10)–(11) to obtain weight a_4, a_5. The results of weight a_4, a_5 are shown in column 4 of Table 6.

According to the formula of standardization weight, use formula (12) to obtain standardization weight $\boldsymbol{w}$. The results of weight $\boldsymbol{w}$ are shown in column 5 of Table 6. The weight $\boldsymbol{w}$ in column 5 of Table 6 is final weight of project risk model (3).

4.3 Establishing Model

Applying weight $\boldsymbol{w}$ into formula (3), the final measure model for the project risk is defined in (13):

$$R_P = 0.268 \times R_1 + 0.109 \times R_2 + 0.177 \times R_3 + 0.238 \times R_4 + 0.208 \times R_5 \quad (13)$$

The features of the formula (13) lie on using the five risk elements to reflect the project risk R_P and determining the importance degree of the five risk elements. Moreover, formula (13) solve measure problem of business project risks when the commercial banks can not fully grasp the project information.

5 Conclusion

Important degree of the project risk elements is listed in descending order: government risk R_1 ($W_1 = 0.268$), investment risk R_4 ($W_4 = 0.238$), credit risk R_5 ($W_5 = 0.208$), policy risk R_3 ($W_3 = 0.177$), industry risk R_2 ($W_2 = 0.109$).

This paper uses G1 method, Maximizing Deviation method, linear interpolation method to determine project risk R_P, to solve measurement problem of business project risks in the case of the limited project information.

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A New Framework on Monitoring Equipment Technology Reformation Project Management Based on Petri Net

Xing-cun Sun, Hao Wu, Qiang Wang, and Su-ling Jia

Abstract Petri net has been proved effective in modeling and simulating project management processes. This paper applies it in the technology reformation project management and constructs a model for the management processes. By integrating the model and the existing project management systems under Service-Oriented Architecture (SOA) pattern, project managers can monitor the project's progress and budget in time and get the simulation results. In this way, they can control the progress and budget. This paper gives a new framework of real-time monitoring. The framework can be widely applied in other project management.

Keywords Modeling • Petri net • SOA • Technology reformation project management

1 Introduction

In recent 10 years, Petri nets have been widely applied in practice. Relying on its several extensions and computer-aided automation tools, Petri net have become a powerful tool to model and analyze industrial systems. Its applications have extended from protocol, hardware and embedded system to flexible manufacturing systems, logistics, office automatic and business process (Chong-yi Yuan 2005). This paper studies its use in processes of project management.

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1.1 Equipment Technology Reformation Project

Modern project management discipline originated in 1950s American, when the project managers took advantage of CPM and PERT to improve the management level of project schedule. After 1980s, the knowledge system of project management becomes more complete, which reveals the nature of project management. Accordingly, the practice becomes more standard. Therefore, the research about project management walks towards the direction of diversification and multidisciplinary. The theory and its application emphasize the scope definition and management methods of project.

In enterprise's operation, technology reformation projects are becoming more and more important. That is true not only for manufacturing organizations such as large aviation enterprises, but also for companies which depend on a flow of new products and services to remain competitive, such as automotive and electronics. By continuous reformation to technology, workmanship, equipment and management methods, the enterprises can expand capacity, produce new products, improve production's quality and get more economic benefits (Chang Luo et al. 2007).

In this paper we mainly focus on the equipment technology reformation project. It is a kind of engineering projects usually containing purchasing behavior which is technologically intensive. The research, design, and development facilities are the cores of the whole project. The implementation of these projects mainly depends on cooperation and outsourcing. Therefore, the key point of equipment technology reformation project management is dynamic management and control from the whole, not the details of implementation. How to implement the project successfully according to the plan becomes a concerning point.

In the past 30 years, the development of information technology and information system injects new power into project management, making it easier for the managers to control the risks of projects. However, the project management systems cannot fully satisfy the needs. That's decided by the nature technology reformation projects. Technology reformation projects are inherently complex and dynamic, involving multiple feedback processed and nonlinear relationships (Sterman 1992). There will have problems if they are treated statically within a partial view of a project. As a result, schedule delays and cost overruns are common in these projects in spite of advances in information systems and other management techniques (Park and Pena-Mora 2003). Integrating project information system and simulation model can offer a powerful mechanism for the project planning. As an extension of this idea, this paper presents an integrated modeling framework to support both real-time monitoring of processes and its possible results. Therefore the project managers can find problems and control the risks in time.

1.2 Petri Nets

Petri nets are a class of modeling tools with a well-defined mathematical foundation and an easy-to-understand graphical feature, which were created by C.A. Petri

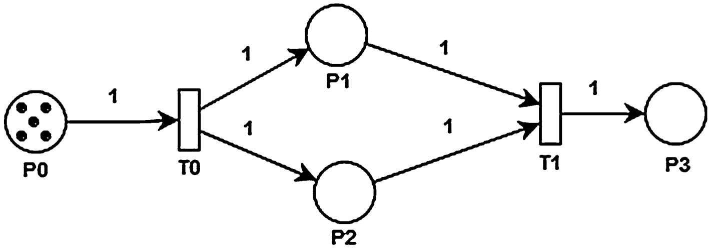

Fig. 1 The structure of a Petri-nets

(1962). The graphical nature of Petri net makes it self-documenting and a powerful design tool, which facilitates visual communication between the people who are engaged in the design process. Besides, Petri net is based on a strong mathematical formalism, which makes it possible to set up mathematical models describing the behavior of the system (Murata 1989). Moreover, validation of the model can be carried out by using Petri net analysis techniques. Petri nets are especially suited for modeling and analyzing the discrete event dynamic system whose behavior is characterized by parallelism and synchronization (Dicesare et al. 1993).

As in Fig. 1, a Petri net is a directed graph consisting of three structural components-places, transitions, and arcs (Salimifard and Wright 2001). Places, which are drawn as circles, represent possible states or conditions of the system while transitions, which are shown by boxes, describe events that may modify system states. The relationships between places and transitions are represented by a set of arcs, which are the only connectors between a place and a transition in either direction. The dynamic behavior of a system can be represented using tokens, which graphically appear as black dots or figures in places.

Petri nets have long been used in modeling and simulating project execution because of their great capability to describe concurrent activities and simulate the evolvement of processes (Yen-liang Chen et al. 2008). Currently researches on the crossing field of project management and Petri net models mainly focus on two aspects: one is studying real-time monitoring; the other is dealing with resource conflict. This paper aims at the first aspect.

1.3 Service-Oriented Architecture

Service-Oriented Architecture (SOA) is a new generation of architecture ideology, which gives service-oriented solution framework in certain circumstances. It is mainly used to solve the problem of business integration among different applications under Internet. SOA involves both business and technology fields (Xiao-Dong Ling 2007), just as Fig. 2 shows. There is no agreed definition of it until now.

In reality, SOA is not only an architecture, but an architectural pattern from which an infinite number of architectures can be derived. The framework in this

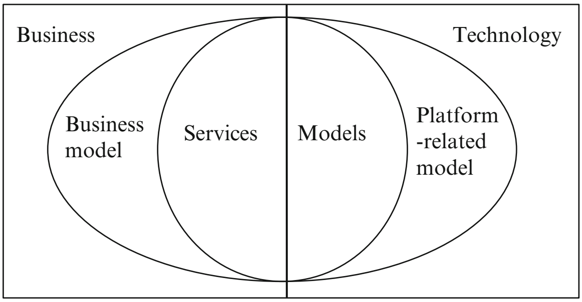

Fig. 2 Scope of SOA

paper derived from SOA is a bridge that connects simulation model with project management systems. The core of SOA is the services between business processes.

Services can communicate with each other, which may deliver data or coordinate to conduct some activities. Since the services and project management systems are separate, it's easy to develop a service as long as the requirement for the data is clear and explicit.

2 Project Management Modeling

2.1 Business Processes Analysis

From the aspect of project's whole life cycle, the process of equipment reformation can be divided into four parts: feasibility study, investment and implementation planning, implementation and acceptance. Successful project management insures the completion of project in time, within cost, and to the project specifications (Babu and Suresh 1996). This paper mainly focuses on the phase of implementation that is full of uncertainties and treats the other phases as the input and output of the implementation system.

Figure 3 shows the business processes of an equipment project. We take planning as the start, which sets up schedule and budget for the following phases. To deal with the uncertainties of technology reformation project, the project managers will organize the proposal reviews for two times. Only the approved proposals can go on to the next phase, or else the proposals should be designed again according to the review advices. The first design of proposal is made by the end users and reviewers are technology department, quality department and other related experts. This phase ascertains technical index that will be used for bidding. Through bidding, contractor is selected and contract is signed. After that the contractor should design the detailed proposal on the basis of investigation research. When the proposal is finished, the enterprise should form a review team to check the proposal. If the proposal is approved, the contactor begins to develop the equipment according to the schedule in contact. When equipment is developed and transported to the enterprise,

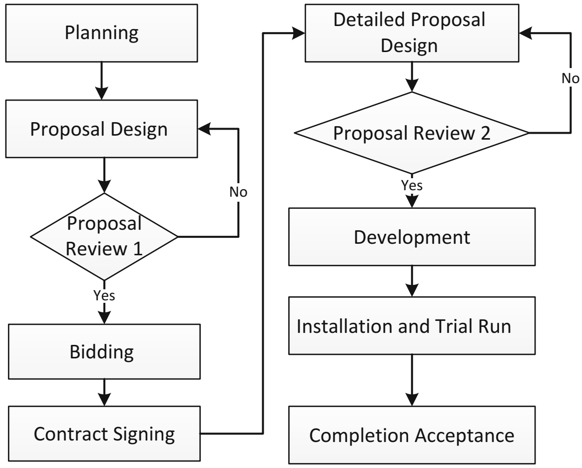

Fig. 3 Business processes of equipment project

the following processes will be installation, trial run and acceptance. In Fig. 3, the phases of detailed proposal design and development are mainly completed by the contractor.

The factors of time and cost are reflected in every phase of business processes. Compared with common projects, the equipment development project needs to be reviewed twice, which guarantee the quality of designs. From the phases, we can conclude research, design and develop are three processes of this kind of projects.

2.2 Petri Net Modeling

In spite of considerable effort over the past years on improving project management, technology reformation projects are still failing to achieve cost and schedule budgets. The major reason for continued schedule and budget performance problems is that while projects are fundamentally complex dynamic systems, most project management concepts and tools: (1) View a project statically; (2) Take only a partial, narrow view in order to allow managers to mentally cope with the complexity; (3) Foster the perception that each project is unique, and therefore make systematic learning across projects difficult (Reichelt and Lyneis 1999).

Petri nets can dynamically represent the process planning and execution condition. According to business processes above, we model the equipment reformation processes as Fig. 4 and Table 1 gives the meaning of every node. The places represent states of project and the transitions represent activities which result in the change of project states. In the model, every transition is associated with a duration attribute called planned execution time (PET) and a capital attribute called planned execution cost (PEC), which get data according to plan. To keep track of the execution of projects, the model attaches another two temporal attributes to

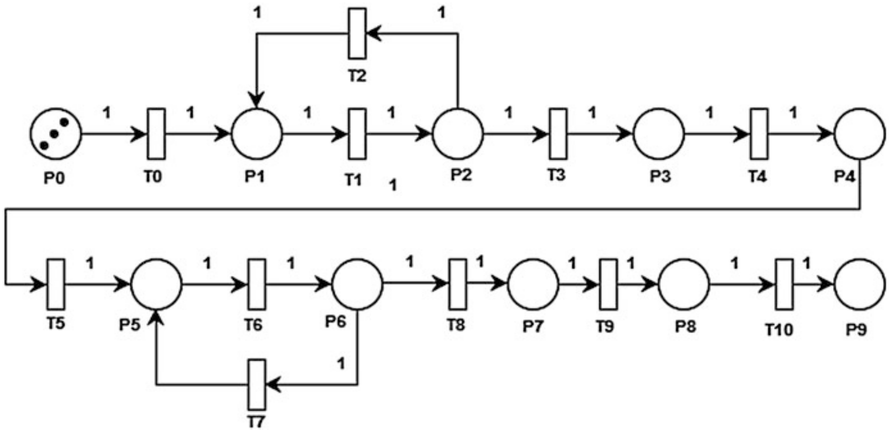

Fig. 4 Petri-nets model

Table 1 The meanings of transitions and places

Tra[a]	Business meaning	Pla[b]	Business meaning
T0	Design proposal	P0	Phase of planning
T1	Review proposal	P1	Proposal without review
T2	Redesign proposal	P2	Review Result (yes /no)
T3	Bid to select contractor	P3	Contractor selected
T4	Official contract	P4	Sign the contract
T5	Design detailed proposal	P5	Detailed proposal without review
T6	Review detailed proposal	P6	Review Result (yes/no)
T7	Redesign detailed proposal	P7	Facilities finished
T8	Develop facilities	P8	Facilities tested
T9	Install and test	P9	Accepted facilities
T10	Accept		

[a]means Places
[b]means Transitions

all places. The two attributes are the accumulated execution time (AET) and the accumulated execution cost (AEC). The outputs of transition T1 and T6 depend on the experience data which can be very different according to the complexity and type of equipment. If review didn't pass, the proposal has to be redesigned until it is given the green light.

When executing the model to simulate process of a project, we should add one token into P0 and set the initial values of AET and AEC as zero. The transitions will be triggered one by one until the token gets to P9. At the same time, the values of AET and AEC will increase with the planned time and planned cost. When the "project" is finished, the accumulated cost and accumulated time are the total time and cost that project needs from the beginning to the end.

3 Monitoring and Controlling Framework

The simulation model couldn't realize real-time monitoring unless we deliver the real execution time and cost to the model to take place of the planned time and cost. SOA framework supports data- and process-aware service-based delivery (Vouk 2008), which can be used to integrate Petri net models and business systems.

The elements in the SOA pattern include applications, service descriptions and implementations, and possibly a service bus (Lewis et al. 2007). Figure 5 shows the framework of real-time monitoring and controlling. In this framework the Petri net model is in application layer. The business meaning and related content of every transition can be service descriptions which are used to design services for each transition to get the required data. Data bus is composition layer which controls the service to find the corresponding system. Project-related systems are as the legacy systems which can collect project business data. Service can get required data from these systems.

The framework can monitor the real-time execution of projects by replacing transitions' planned time and cost with actual time and cost. At the same time, the unexecuted transitions keep the planned or the revised values, or the delay values which are usually higher than the planned. Through simulation, we can get the result of total time and cost that project will take. Project managers can adjust the plan from an overall perspective, not a partial and narrow view as the previously proposed, and get to know the possible result which insures the project can be finished as the planned.

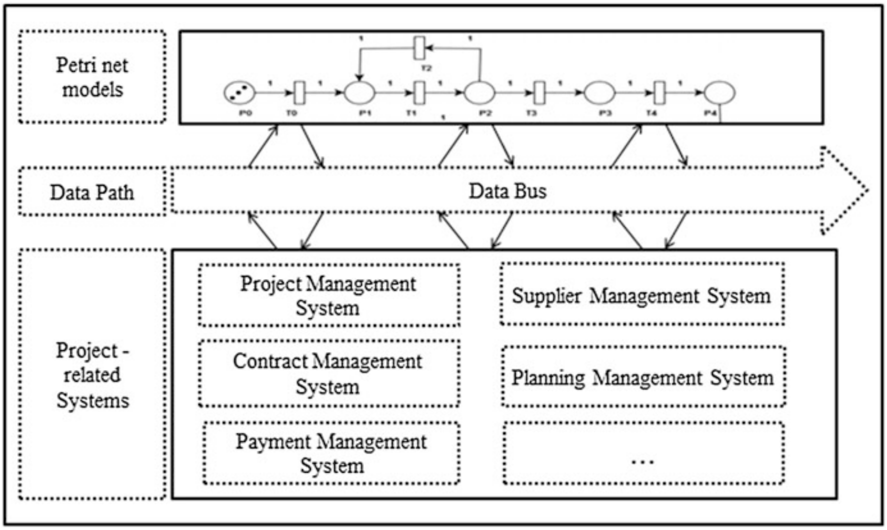

Fig. 5 Monitoring and controlling framework

4 Conclusion

Integrating the operational details of the traditional approach and the strategic views of the system dynamics modeling approach can offer a powerful representation mechanism for constructing project planning (Rodrigues and Bowers 1996). As an extension of this idea, this paper uses SOA pattern to integrate Petri net models and the existing technology reformation project management systems in enterprises. By the implementation of this framework, the information in project management systems can be fully used to help project managers monitor the status of projects; the framework can effectively solve the problem of schedule delays and cost overruns.

With graphical representations, Petri nets can model project business processes easily; services can be designed easily without considering much about systems. The Petri net model can be built according to different context and the corresponding services can be designed easily. So this framework can be widely used in the field of project management.

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Effect Analysis of FDI on the Construction Industry Competitiveness

Jia-qiang Mao, Jia-jia Wang, and Kun Jing

Abstract With the development of economic globalization, construction industry of China is gradually connecting with the global industry. Confronting with the new competitive environment, it is important to enhance the competitiveness of large construction enterprises. With the entering of foreign large contractor, Chinese construction enterprise will face lager pressure of foreign competitiveness. Based on the total factor productivity model, this article analysis the relationship between FDI and the competitiveness of enterprises. The result shows that FDI is positively correlated with the competitiveness of enterprises in general, and it mainly use their own factor productivity, but not by foreign-funded enterprises on the domestic spillover effect.

Keywords Competitiveness • Construction enterprises • Foreign direct investment • Technology spillover effect

1 Introduction

Since 1993, China has been the largest developing country to attract foreign investment for 19 years. As a full-competition industry, construction enterprises have to face the most competitiveness market. Especially after China joined the World Trade Organization (WTO), many foreign companies entered into China's market. This made Chinese market much more competitive than ever since. Those foreign companies always have advantages like strong financial capability, high-tech machines, and high level management skills (Jiang 2010). No matter in the aspects like initial survey and design, or in the aspects like equipment procurement

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and construction, these companies can do it all by themselves. Therefore, they will rely on these advantages to seize a share of the construction market in our country, and become a huge threat to local construction enterprises.

In essence, the enhancement of enterprises' competitiveness is an enhancement of production efficiency (Baniak and Herezynski 2005). Only when the production unit has advantages in productivity, it may have the chance to win in the competition. This process requires a variety of resources, such as labor, domestic capital, foreign capital, technology and so on (Deichmann et al. 2003). But the problems such as "whether these resources will help to improve the competitiveness of the construction industry?", "what is the role of foreign investment played in the process of improving the competitiveness?", "whether different nature of foreign investment do different impact on the enhance of competitiveness in the construction industry?" are all affect the quality of foreign investment utilization (Halverson 2002). In order to fully reflect these problems, total factor production function is considered as a basis to build an empirical model about how Foreign Direct Investment (FDI) affect the competitiveness of enterprises.

2 Model Overview

Productivity is the output of every unit input. From the enterprise level, it is the ratio of unit price and unit cost (Kinoshita 2001). It is measured by the production function. Because using production function can comprehensive reflect the relation among input, output and productivity in various industries (Santangelo 2005). Here article assume that the main input elements are labor and capital. And it use time variable to represent the impact of technical input to output. So the production function can be described as:

$$Y = F\left(K, L, t\right) \tag{1}$$

Assume that technological change is Hicks-Neutrally, production function can be written as:

$$Q = A(t)\ f\left(K, L\right) \tag{2}$$

Where *A(t)* represents the cumulative effect of technological change in the above formula. The common Cobb-Douglas production function is:

$$Q = Ae^{\gamma} K^{\alpha} L^{\beta} \tag{3}$$

Where γ is the coefficient of technological progress, α, β represent the output elasticity of capital and labor input. According to the endogenous growth theory, A represents the technology spillover of FDI. Then endogenous technological progress can be expressed as:

$$Y = B\,(1 + \eta Share)\,FDI^{\theta}\,K^{\alpha}\,L^{\beta} \tag{4}$$

Taking the natural logarithm on both sides at the same time, following equation will be obtained:

$$lnY = ln\,(1 + \eta Share) + \theta lnFDI + \alpha lnK + \beta lnL \tag{5}$$

Using approximate estimate can concluded that: When Z is small, $\log(1 + z) \approx z$, then we estimate the above equation and concluded that:

$$lnY = ln\,B + \eta Share + \alpha lnK + \beta lnL \tag{6}$$

On this basis, we have introduced several separate indicators in order to make the model better fit. Specific form is described as follows:

$$lnY = lnB + \eta Share + \theta lnFDI + \alpha lnK + \beta lnL + \varepsilon \tag{7}$$

Coupled with the time factor, and the mathematic model will be shown:

$$lnY = lnB_t + \eta Share_t + \theta lnFDI_t + \alpha lnK_t + \beta lnL_t + \varepsilon \tag{8}$$

When we estimated production function, the traditional way is to estimate the relationship between the value added and capital (or labor) inputs (Zhou et al. 2002); If the output value or sales revenue used as the output variable, then we generally need to re-introduce the intermediate inputs (for example, raw materials, energy, etc.) or stock variables in the input variables (Barney 2001). The reason why this model only uses Y, K and L, but without the introduction of intermediate inputs and inventory variables is that: First, the gap between raw materials and inventory in single enterprises data is relatively large (Gallon et al. 1995). This make us be limited when selected the variables; Second, using sales income as a measure of indicators can not only measure sales ability, but also reflect the inventory management capabilities in an enterprise. Meanwhile, the intermediate input variable is not introduced, and it can also measure the ability of an enterprise to obtain intermediate inputs. As a result, the total factor productivity become more broadly. It will not only consider the efficiency of the production technology, but also consider the operation and management efficiency of enterprises (Christmann and Taylor 2001). This coincided with the original intention of our study. Because the spillover effects are always manifested as these two aspects at the same time; finally, companies in specific industries maintained a certain ratio sales between revenue and intermediate inputs (Dean Judith et al. 2005). To a certain extent, the introduction of the industry variables will reduce the differences between the input and output in the industry, so we can ensure the reasonableness of the estimated results.

1. Y represents outputs of the enterprise, it usually measured by the data of enterprise sales income. The unit is 10,000 Yuan.

2. FDI represents the actual amount of FDI. It has two types: contract foreign investment and actual foreign investment. The contracted foreign capital can only express the overall size of FDI, however, the actual foreign investment express the amount of foreign investment which have been injected into the process of production and operation. Compared with the contracted foreign investment, actual foreign investment will have larger practical significance on business process outputs.
3. B represents the residual value of the total factor productivity; it is mainly used as a measure of other factors affecting the technological progress.
4. Share represents the proportion of FDI in total investment.
5. L represents the number of employees at the end of the year.
6. K was measured by the investment in fixed assets of construction enterprises.

3 Data Description

This section is an empirical test of the enterprises' competitiveness. We expand the analysis by extract relevant indicators in all types of businesses within China's construction industry (Including foreign owned, joint ventures and other forms). Considering that not only the amount of FDI inputs may affect the competitiveness of enterprises, but also the proportion of total FDI investment can also do a function to the certain extent. Therefore, we put these two factors as explanatory variables when establishing the model. So the coefficient of FDI, the coefficient of SHARE is the main object of the next measurement analysis.

1. θ represents the coefficient of foreign-funded enterprises' relative productivity which compared with domestic enterprises. It reflects the direct role that relative factor productivity advantages of foreign-funded enterprises do on the technological progress. For coefficient of θ, if the statistics are significant, then $\theta > 0$ represent that FDI and the enhancement of the competitiveness of enterprises have a positive correlation and FDI will enhance the competitiveness of construction enterprises. $\theta < 0$ indicates that FDI and the enhancement of the competitiveness of enterprises have a negative correlation. FDI will inhibit the architectural enhancement of the competitiveness of enterprises; If the statistical results are not significant, it means that no significant correlation between FDI and competitiveness of enterprises.
2. For coefficient η, if the statistics are significant, it means that the share of FDI in total capital has a positive correlation on the improvement of production efficiency. $\eta < 0$ explain that the share of FDI in total capital and the enhancement of construction enterprises' competitiveness are negatively correlated. FDI will inhibit the enhancement of the enterprises' competitiveness. On the contrary, if the statistical results are not significant, it explained that the correlation between the share of FDI in the invested capital and enterprise competitiveness is not significant. The data used in the econometric analysis of this paper is collected

Table 1 Economic data of construction enterprises

Year	Output value	Employment	Paid-in capital	Actual use of FDI	Share (%)
1995	5, 793.8	1,497.9	1, 261.4	22.5	1.78
1996	8, 282.3	2,121.9	1, 936.1	38.2	1.97
1997	9, 126.5	2,101.5	2, 231.7	51.3	2.79
1998	10, 062	2,030.0	2, 280.5	59.4	2.60
1999	11, 152.9	2,020.1	2, 675.5	69.2	2.59
2000	12, 497.6	1,994.3	3, 219.8	72.5	2.25
2001	15, 361.6	2,110.7	4, 518.6	81.2	1.80
2002	18, 527.2	2,245.2	5, 855.6	98.0	1.67
2003	23, 083.9	2,414.3	6, 540.8	102.3	1.56
2004	29, 021.5	2,500.3	7, 297.5	115.6	1.58
2005	34, 552.1	2,699.9	8, 171.4	131.5	1.61
2006	41, 557.2	2,878.2	9, 032.6	132.8	1.47
2007	51, 043.7	3,133.7	9, 982.0	149.9	1.50
2008	62, 036.8	3,315.0	11, 887.2	165.9	1.40
2009	76, 807.7	3,672.6	13, 284.3	177.5	1.34
2010	96, 031.1	4,160.4	15, 391.4	180.0	1.17
2011	117, 059.7	3,852.5	18, 020.7	198.2	1.10

from the data which published on the website of the national bureau of statistics from 1995 to 2011.

The measuring data shown in Table 1 in was derived by the data published on the website of the national Bureau of statistics from 1995 to 2011.

4 Empirical Test

4.1 Unit Root Test

Panel data is the unity of time series data and cross-sectional data, Therefore, using panel data will result in non stable unit root problem especially in the case of a longer time dimension (Dasgupta et al. 2002). If panel data sequence is non stationary, using existed panel data directly to build models will likely to lead to spurious regression (Eskeland and Harrison 2003). So before regression analysis, unit root tests will be need on panel data. The results are shown in Table 2:

From Table 2, we can obtain: in the 1 % significance level, only variable Y is smooth variable; K, L, FDI and Share comply with the stationary test requirements under the significant level of 5 %; therefore, we can determine that the variables are stationary series. In this paper, data from 1995 to 2011 were used, and the time span is relatively short. That will make the test results deviated. But it still has greater credibility overall. We can determine that the data selected in this paper is stationary series.

Table 2 Result of unit root test

Sequence	ADF statistics	1 % threshold	5 % threshold	10 % threshold
lnY	−3.453988	−2.84725	−1.988198	−1.60014
lnL	−2.342326	−2.84725	−1.988198	−1.60014
lnK	−2.381772	−2.754993	−1.970978	−1.603693
lnFDI	−3.588786	−4.05791	−3.11991	−2.701103
lnShare	−2.629609	−2.81674	−1.982344	−1.601144

Table 3 Analysis of the correlation between the variables

	LNY	LNL	LNK	LNFDI	LNShare
LNY	1	0.963879	0.980965	0.941208	−0.78616
LNL	0.963879	1	0.927889	0.915684	−0.68249
LNK	0.980965	0.927889	1	0.9661	−0.78616
LNFDI	0.941208	0.915684	0.9661	1	−0.59997
LNShare	−0.78616	−0.68249	−0.78616	−0.59997	1

Table 4 Overall regression results of the model

Multiple R	R square	Adjusted R square	Standard error
0.993205	0.986457	0.981039	0.110385

4.2 *Empirical Analysis and Results*

In order to have further test about whether the variables in the model is multi-collinearity or not, this article do a related analysis. It is generally believed that, as long as the correlation coefficient is more than 0.5 or less than −0.5, the correlation between variables is more significant. Specific analysis is shown in Table 3:

In summary, within function

$$lnY = lnB_t + \eta Share_t + \theta lnFDI_t + \alpha lnK_t + \beta lnL_t + \varepsilon_t \tag{9}$$

The correlation coefficient of the dependent variables and the three independent variables (lnL, lnK, lnFDI) are above 90 %. The correlation coefficient of the dependent variables and lnShare is also less than −59 %. These indicate the credibility of this model, it can carry out the next step of the regression analysis. Then we do regression analysis of the model with the help of Eviews6.0, and the following results will be obtained:

From above Tables 4 and 5 we can conclude that: Independent variables like constant, LNK, LNFDI can get though the T-test under 5 % significance levels. And symbol in front of the respective coefficient is basically the same as expected. This is line with basic research. R Square and Adjusted R Square are greater than 0.98, and this means that the model is highly fitted. Through the simulation of the model regression, we can clearly see the relationship exists between these variables:

Table 5 Result of the linear regression

	Coefficients	Standard error	t stat	P-value
Intercept	−4.21192	3.214901	−1.31012	0.219449
lnL	1.47917	0.357936	4.132497	0.002036
lnK	0.134249	0.750213	0.178948	0.861552
lnFDI	0.423747	0.72206	0.586859	0.570309
lnShare	−0.66858	0.654576	−1.02139	0.331144

$$\begin{aligned} lnY = -4.212 + \underset{(4.132)}{1.479lnL} + \underset{(0.179)}{0.134lnK} + \underset{(0.589)}{0.424lnFDI} - \underset{(-1.021)}{0.669lnShare} \end{aligned} \tag{10}$$

As it can be seen from Eq. (10): K, L, FDI are positively correlated with Y, only Share and Y is the negative correlation. Specifically, each 1 % addition of the capital investment can lead to 0.134 % raise on output. The majority of construction enterprises in China is still in the low-end industries, they mainly achieve the economies of scale by the means of expanding the scale of business, and reducing production costs to gain a competitive advantage. This manner will generally lead to inefficient competition, costs expansion and other adverse conditions. On the contrary, foreign-funded enterprises have the financial advantage, and willing to invest the money to improve the technical level, so the products they produced is more competitive, especially compared with the local products. At this time, the companies have skipped the price war and rise to a higher level of competition. Therefore, the continuous investment on construction enterprises can promote the rapid development of enterprises. Every 1 % increase of the personnel investment will increase the output value of 1.479 %. So we can see that the construction industry is still based on labor-intensive model. The development model needs to be improved. Moreover, for construction enterprises, K and L inputs are complementary. With the increase of business investment, investment in the labor force will be inevitably increased by a fixed ratio. Therefore, the effect of L and K are more similar.

As to foreign investment aspects, each additional 1 % of the actual foreign investment will be able to bring the 0.424 % increase in output value. Judging by the data, the increase in foreign investment plays a more significant role than the total capital investment. Thus, foreign technology spillover is more obviously performance. It is reflected in the investment in technology and training of technical workers which is more important.

On the other hand, the proportion of FDI in total investment cannot explain sales revenue, this is because the proportion of FDI cannot directly impact the production operation and management of the enterprise. And what's more, with respect to the foreign investors, China's local enterprises are better understand the construction market information than foreigners, so, even if the proportion of FDI increases, most foreign investors still try to choose local managers in the company. This is consistent with the situation in the majority of industries in China, Therefore, this article cannot temporary inspected the direct effect of relative factor productivity advantages in promoting technological progress of foreign-funded enterprises.

5 Conclusion

In order to analyze the impact of FDI on the competitiveness of China's construction enterprises, this article intercept data between 1995 and 2011, and decomposed total factor productivity formula to study the way of foreign investment impact on construction enterprises. It mainly analysis the impact of foreign direct investment do on the competitiveness of construction industry. From the measurement results, we can get the following conclusions:

1. Capital investment and staff inputs produce more obviously technological spillovers. This shows that the construction enterprises well absorbed and expanded in the process of technology spillover. There are several reasons: First, China's local enterprises have strong imitator ability; Second, it is benefit from the cooperation of the supply chain of the construction industry; at last, the frequently exchanges between domestic and foreign enterprises provide a platform for the movement of persons.
2. The more did foreigners invests, the more output did enterprise make. However, this effect is not significant. This shows that our local construction enterprises need extended on the width and depth of the utilization of foreign capital. This also indicates that the market of foreign investment is mainly vested in foreigner's hand. So the market of domestic companies is relatively fixed and difficult to expand. Market control ability of local enterprises need to be improved.
3. Labor still plays a dominant role in construction enterprise's development. Therefore, when the company committed to expand the business scale, it also needs to pay more attention to the skills training of the general staff in order to improve the overall quality of staff. On the other hand, enterprises should expand the proportion of investment in capital and technology, and try to change purely labor-intensive development model.
4. Although FDI affect the total factor productivity of construction enterprises through relative increase in productivity and the spillover effects at the same time, foreign investment in the business generated positive direct effect is greater than its negative effects on the spillover effects of domestic enterprises. So generally speaking, foreign investment plays a role in promoting China's construction enterprises. And at this stage, the way foreign-funded enterprise promoted on the technological progress of China's construction enterprises is the increase of factor productivity, rather than foreign-funded enterprises on the domestic spillover.

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Engineering Project Management Evaluation Based on Team and Structural Equation Modeling

A-di Zhang and Yu-heng Zeng

Abstract How to evaluate the performances of an engineering project management and what's the key factors were important and hot topics in theories of practice of projects management field. This paper analyzed engineering project management in view of teams, summarized factors of engineering project, performances of successful engineering project, and built an engineering project management evaluation model. Then analyzed the model with statistics and structural equation modeling, and extracted some key factors or performances for engineering project management.

Keywords Engineering project management • Factor analysis • Performance evaluation • Structural equation modeling

1 Introduction

A project is a team cooperation progression frequently involving carefully plans and implements for particular aims. Engineering projects are projects for design and construction of buildings, power plants, industrial facilities, installation and erection of electrical grid networks, transportation infrastructure and the like.

The most popular indicators to differentiate successful projects were time, cost and performances (Hulzler 2003). The famous Sydney Opera House, one of the most profitable tourist spots in the world, was postponed, cost overruns and conflicts heavily from 7 million Australian Dollars in 5 years to 100 million dollars in 16 years (Schenha and Dvir 2007). If we evaluated the project from time and budget, Sydney Opera House were a traditional failure case, but if we evaluated it from the

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long time financial performances and external performances, it made a great success for Australia.

There were uncertainties in project progressions, and the successful rates of projects were always low. So finding the real or key factors of success for engineering projects was a vital issue for engineering projects management theories or practices.

2 Performances Measure for Engineering Projects

Every project starts off with good intentions: (1) all stakeholders will be pleased with the results, (2) It will be on time, (3) within budget, (4) meet all the requirements of the job, and (5) function trouble-free (Tim Lajiness and Dale Feldhaus 2011).

To meet the profit preferences of customers, stakeholders and project teams, the qualities of products or services were high, the time or budgets were short. And some of the intentions were paradoxical, for example, if we had more time and more budgets, we could give more perfect buildings, products or services to customers. But the performances of engineering projects were more important than time or budgets generally.

In the base of customer orientation, strategy and externalities, the quota to illustrate engineering project management success were sorted as following, which were summarized in Table 1:

2.1 Satisfactions of Customers or Stakeholders and Time

Engineering projects were some work which gave products or services to customers, so customer's satisfactions were the first important item to consider. Stakeholders

Table 1 Performances quota of engineering project management

Order assumed	Latent items	Measured indicators
1	Satisfactions of customer or stakeholders	Satisfactions of customers
		Time
		Satisfactions of stakeholders
2	Financial performances	Long returns
		Short returns
		Costs and budgets
3	Organization learning and growth	Organization learning
		Organization growth to strategy
4	External performance	Reputation promotion
		Harm to society
		Harm to environment
		Harm to employee

had great influences to engineering projects, and the good satisfactions of all stake holders were one of the targets of engineering project management.

The values of engineering projects were closely connected with time, and time value was reflected in the whole progressions including finance foregoing. But time is corresponding to other performances especially the product qualities of engineering project, so if timeliness would be pivotal items to engineering project management performances lied on its corresponding other performances such as financial return or customers' tolerances and preferences.

2.2 Financial Performances

Engineering projects were some economic business to earn money for customers or project subject teams. Financial performances of engineering projects and their management were important items to consider, which included long returns, short returns, costs and budgets.

2.3 Organization Learning and Growth

Knowledge innovation and organization learning were key factors to organization core competitiveness, development and strategy in knowledge economics nowadays. Here we listed two items of organization learning, organization growth to strategy as the performances of engineering projects management for subject teams.

2.4 External Performances

Many fields or regions in our societies were extensive linked each other in post-industry risk society (Curran 2013), risks and externalities had made more and more impacts to engineering projects. The external performances of engineering projects has good side or bad ones, the good side was represented by reputation promotions, and the bad ones included harm to society, environment or employee in general.

3 Factor Assumptions of Engineering Project Management Base on Team

Projects especially technology engineering ones carried a high rate of failure (Heising 2012), there were some factors crucial to their success' of engineering projects based on team (Brown and Hyer 2009), which were extracted as following and summarized in Table 2.

Table 2 Factors assumed of engineering project management

Order assumed	Latent items	Measured indicators
1	Targets and motivations	Clear common targets Motivations to project team numbers
2	Customer orientation	Know customer and customers' need well Satisfy clients continually
3	Operation and support	Perfect internal operation management Resources and higher level manager supports
4	Plan and leadership	Effective plans Suitable leaderships
5	Uncertainty management and change control	Enough uncertainty management Rigorous change control

3.1 Targets and Motivations

As stimulation, target can stimulate the need of human, and setting an appropriate target can inspire one's motivation and stimulate initiative. Explicit target can make people inspiring and full of confidence (Hwang and Lim 2013). It is important to confirm an appropriate target for a team, make all the numbers clear, agreed or identified the common targets of engineering targets.

Engineering team numbers and stockholders knew the significances of the projects, and projects customers, team numbers and other stockholders were incentive by the project plans well, and they would like to strive for the success of them.

3.2 Customer Orientation

All the work of engineering projects throughout plans to implements were customer orientated, team knew their customers and customers need well, and whether met the need of customers was the most primary factor to the success of engineering projects.

3.3 Operation and Support

Internal business process management is one of the four sides in balanced scorecards of organization strategies (Bisbe and Barrubes 2012), Clear roles and duties, perfect internal operation management, and effective communications with team numbers and stakeholders were four measured indicator for internal business process management.

Engineering projects usually need some necessary resources such as human beings, finances, equipment, work spaces, logistics, information, support system and etc., the higher level managers were able to make sure most resources, supports from top managers were very pointed, too (Jeng 2012).

3.4 Plans and Leadership

Successful engineering projects had integrated excellent plans including project targets, project scopes, customer needs, expected schedule, expected cost, and duties arrangements in the begin, updated with new information continuously, and made by team participations generally (Chen et al. 2012).

There was some leadership necessary in team work, whether they were formal or not. Every engineering project need different level leadership power, and the appropriate leadership patterns rested with the scopes, complexities, strategy stress and cultures.

3.5 Uncertainty Management and Change Control

The lack of certainty is a state of having limited knowledge where it is impossible to exactly describe the existing state, a future outcome, or more than one possible outcome (Heising 2012). There were uncertainties in engineering projects in different degrees, team should analyze and find the methods to avoid or lighten potential negative incidents, push potential positive ones achieved, and got some buffers to accidental crisis efficiently.

Scope expansions were potential trouble for engineering program, which would bring time postpone, budget and resources accretion, scheme change, etc. (Kog and Loh 2012). When information, customer needs, conditions or environments made vital change, scope expansion would be inevitable, and then scope boundary and appropriate change control procedure would be discussed and made decisions formally, in considerations with resources, schedules, qualities and targets.

4 Modeling and Statistical Analysis

4.1 Set Up Structural Equation Modeling for Engineering Project Management

The main targets of this study were to evaluate engineering project management, extract key factors and their relationships for projects success. We set up structural equation modeling based on the theory analysis foregoing.

4.1.1 Measured Modeling

$$\begin{cases} X_i = \Lambda_{ij}\xi_i + \delta_i \\ Y_i = \Lambda_{ij}\eta_i + \varepsilon_i \end{cases} \tag{1}$$

where ξ_i, η_i denoted exogenous or endogenous latent variables, $i \in [1,5]$ for ξ_i, and $i \in [1,4]$ for η_i, X_i, Y_i denoted related measured variables for the latent ones, Λ_{ij} denoted factor loadings from latent variables to measured ones, $j \in [1,2]$ or [1,4], δ_i, ε_i denoted residuals of latent variables to related measured ones.

4.1.2 Structure Modeling

$$\eta = B\eta + \Gamma\xi + \zeta \tag{2}$$

where ξ, η denoted vector of exogenous or endogenous latent variables, B denoted factor loadings vector of β_i, which was loading from η_{i} to η_{j}, Γ denoted factor loadings vector of $\gamma_{\mathrm{i},}$ which was loading from ξ_{i} to η_{j}, ζ denoted residuals vector of exogenous latent variables to endogenous ones, ξ has no relationships with ζ.

4.1.3 Structure Equation Modeling Diagram

Based on the structural equation modeling for engineering project management, drawled its' diagram in Fig. 1 following.

4.2 Statistical Analysis

We made a questionnaire survey to employee in Chinese construction industry, and choose respondents with career experiences. Finally we got 357 effective questionnaires. The questionnaire general Cronbach's $\alpha = 0.893$, latent variable's Cronbach's α were in the range of [0.8, 0.9], the reports showed the data had a good reliability, and the survey were homogeneous enough.

We used the high efficient parameter estimation method maximum likelihood estimations, after scatter assessment to normalizes well. From the fitting report of SEM, we summarized the main quota of general goodness of fitting test, including X^2/DF, P, NFI, NNFI, CFI, IFI, GFI, AGFI, RFI, RMR, RMSEA in Table 3, which showed that the general modeling were fitted well with the sample data.

Most of factor loadings of all the variables above were between 0.45 and 0.9, and went beyond them, but the factor loading of measured variable Y41 was 0.12, and it was obviously a question to be adjusted. Then we saw a bigger numbers 50.156 in

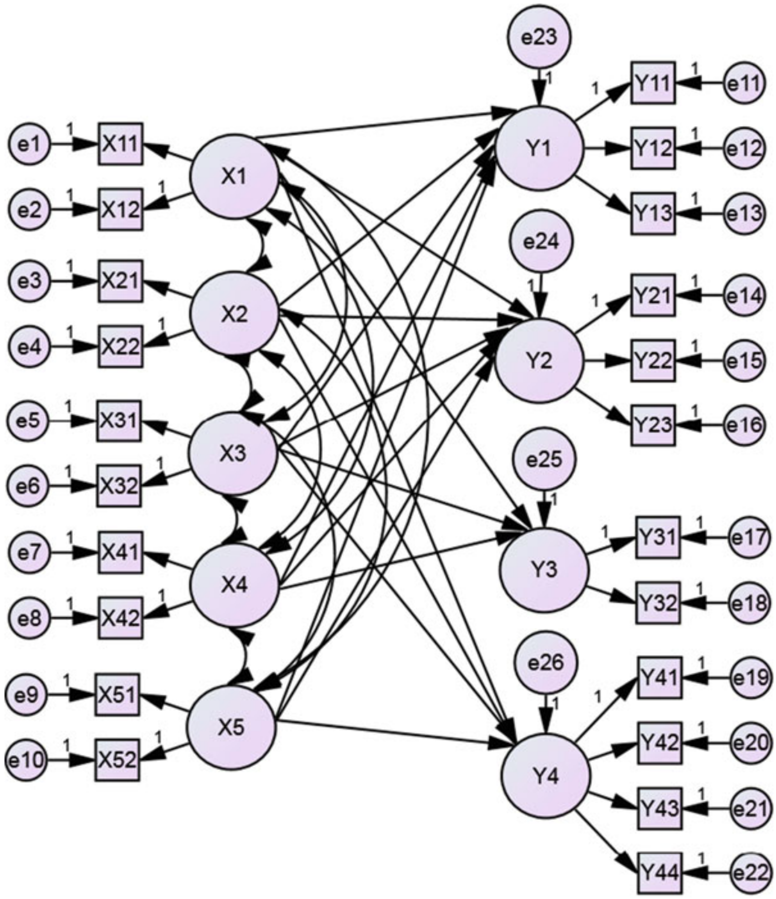

Fig. 1 Structure equation modeling diagram of engineering project management evaluation

Table 3 Model general goodness of fitting tests

Goodness	X^2/DF	P	NFI	NNFI	CFI	IFI	GFI	AGFI	RFI	RMR	RMSEA
Criterions	(2.3)	<0.1	>0.9	>0.9	>0.9	>0.9	>0.9	>0.9	>0.9	<0.035	<0.08
Origin model	1.529	0.01	0.881	0.917	0.864	0.903	0.867	0.819	0.841	0.0603	0.0571
Modification model	1.580	0.01	0.902	0.927	0.874	0.914	0.8	0.851	0.858	0.0493	0.0540

modification indices for Modification indices Γ-X. So I had changed the route from Y4 to Y1, and recalculate the modeling fitting with Amos.

Goodness index of fitting tests of the modification model were generally better than the original one, and the factor loading of Y41 in Y1 became 0.49, so the relocation decision of Y41 from Y4 to Y1 were advisable.

5 Conclusions

From the statistical reports of SEM, especially in model fit, modification indices, and estimates comparing original model with modification model, we could find: (1) When satisfactions of customer or stakeholders, financial performances, organization learning and growth, external performances as endogenous variables, the exogenous ones including targets and motivations, customer orientation, operation and support, plan and leadership, uncertainty management and change control were effective factors of engineering project management evaluations generally. (2) According to the factor loading rank, we found customer orientation required to know customer's need well and satisfy them continually, which were the most important factors for engineering project, clear common targets and motivations to team were the next important ones. (3) Uncertainty management and change control were related to the plan effectiveness, long or short returns and external performances directly.

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Part V
Engineering Management – Quality Management and Reliability

Effect of Service Failure Criticality on Recovery Strategy Choosing: Moderating Role of Attribution

Du-sheng Chen

Abstract The paper focuses on the service recovery strategy after failure. It contributes to the literature by exploring the relationship between failure criticality, recovery strategy and recovery outcome. It argues that recovery outcome varies dues to different recovery strategies and criticality of service failure is related to recovery strategy selection. The paper also considers one of the important customers' personal traits – locus attribution as a moderator.

Keywords Locus attribution • Service failure • Service recovery

1 Introduction

In service area, service quality is one of the heavily researched topics, many studies has focused on different factors that constitute service quality and its effect on customer perceptions (O'Neil and Palmer 2004).

Mack et al. (2000) indicates that the multi-dimensional nature of the service encounter creates an environment where failure may unavoidably occur. Service failure happens when service suppliers could not provide the service that meet customers' expectation and lead to dissatisfaction (Smith and Bolton 1998). Service failures can be due to unprompted employee actions (e.g. rudeness), failure to respond to specific customer needs or preferences, or core service failures (e.g. unavailable or unreasonably slow service) (Bitner et al. 1990).

These service failures can vary in severity, frequency, and timing, resulting in dissatisfied customers (Kelley and Davis 1994). As customers are valuable assets

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to companies, the managers often take steps to ensure that when service failures do occur, there are processes in place to respond.

Therefore the service recovery emerges. It referred to as the action undertaken by an organization to face the eventualities of a service failure (Zeithaml and Bitner 2000). Effective service recovery can minimize potential losses of negative word-of-mouth to current and potential customers (Forrester and Maute 2001), improves customer satisfaction and loyalty (Bitner et al. 1990).

Identifying factors that increase positive or minimize negative behavioral responses to recovery efforts is important to the development of successful recovery strategies. This study tries to provide detailed insight to the effect of recovery strategy on customer satisfaction. There are many factors that affect the recovery outcome. On aim of this study is to explore the impact of particular attribution that may influence the recovery results. On another hand, this study follows former researcher's advice that explores the impact of attributions in service failure situations (McCollough 2000).

2 Proposition Development

2.1 Service Failure and Service Recovery

Bitner et al. (1990) and Chung and Hoffman (1998) identified three categories of service failures as:

1. Service system failure: This occurs in core service which is inclusive of product defects (food is cold, etc.) show or unavailable service, facility problem (dirty silverware, insect or rodent problems etc.) unclear, unfriendly policies (like not accepting credit cards) and out of stock conditions (like inadequate supply of menu items).
2. Failures in implicit or explicit customer requests: This occurs chiefly when employees are unable to comply with the customer's individual needs.
3. Unprompted and unsolicited employee actions: This includes behavior of employees that is unacceptable to guests like – rudeness; poor attitude; wrong order delivered; and incorrect charges like charging customers for items not ordered or give incorrect change.

A recent research observation suggests that effective service recovery design should be affected by the unique needs and expectations of the customer (Goldstein et al. 2002). So the attitudes and personal traits of different customers are very important in the effectiveness of service recovery.

Service providers always use two types of recovery strategy to respond to service failure: psychological and tangible (Miller et al. 2000). Psychological actions mean using verbal and emotional responses to service failure (Carson and Carson 1998). When some small failure emerge, only apology can be effective. If the employees can employ empathizing skills, it will be better (Smith and Bolton 1998). Tangible actions involve physical steps that mitigate dissatisfied customers for real and perceived lost like giving some compensation (Chebat and Slusarczyk 2005).

Based on the previous research, this study distinguishes service recovery into four strategies. First is excuse, second is apology, third is excuse and compensation, and fourth is apology and compensation.

Proposition 1 Different recovery strategy leads to different recovery outcomes like customer satisfaction and repurchase intention. The apology and compensation strategy (combination of tangible and psychological response) is most effective one.

2.2 Criticality in Service Recovery

In service encounters, customers have different expectations in relation to the service's criticality (Webster and Sundaram 1998). A service that is highly critical is more likely to have customers that see a service failure as more serious (Ostrom and Iacobucci 1995). The term criticality is quite similar to severity. Greater levels of service failure severity have been found to reduce the effectiveness of recovery efforts (Smith and Bolton 1998). And Sparks and Fredline (2007) proposes the more severe service failures, the lower levels of satisfaction and loyalty. Therefore, understanding the severity of a service failure is very important to service recovery.

Proposition 2 Criticality of certain service failure is related to recovery strategy selection.

2.3 Customer Attribution in Service Recovery

Consumer attributions have been proven to predict many different types of consumer reactions in response to service failure (Van Raaij and Pruyn 1998). The three attribution dimensions of locus (who caused the failure?), stability (is the failure likely to happen again?), and controllability (could the failure have been prevented?) have been empirically shown to influence consumers' complaint intentions, repurchase intentions, word-of-mouth behavior, redress preferences, and anger toward the firm (Folkes 1984).

According to attribution theory, individuals' behavior is based on the causal inferences they process about the world around them (Folkes 1984). Understanding the classification of causes is crucial to predict behavior from attributions. According to attribution theory, customers make judgments about causal relationships that influence their subsequent emotions, attitudes, and behaviors based on three dimensions: stability, control, locus (Weiner 1985). In a service failure context, the first dimension, "stability", means whether the failure is relatively temporary and fairly permanent and unchanging. "Controllability", a second dimension, is related with the extent to which the cause of the service failure is managed by choice. The third dimension, "locus", deals with the issue of whether the cause is located on the side of the customers themselves or on the side of the service provider.

In general, research findings indicate that the more consumers believe a service failure is due to the seller (external locus), is likely to happen again (stable), and could have been avoided (controllability), the more likely they are to complain (Sparks and Fredline 2007). In this study, it represents as the locus attributions.

Attribution is very crucial to service failure, and it is proposed that consumers' attributions are also important during service recovery. McCollough (2000) points out that "in addition to considering the customer's attributions regarding the service failure, the customer's attributions regarding the recovery process must also be considered". Recovery is evaluated separately from the failure and that the recovery "is considered to have a significant impact on customer evaluations, because customers are usually more emotionally involved in and observant of recovery service than in routine or first-time service". In evaluating recovery outcomes consumers identify the potential causes of the outcome and each party's responsibilities for the resolution of the failure. In addition, by engaging in causal search, consumers seek to identify whether the outcome is likely to occur again in similar circumstances.

Proposition 3 The customers' locus attribution can moderate the relationship between recovery strategy and recovery outcome like customer satisfaction and repurchase intention. The more external locus customer is, the higher level of recovery strategy is needed to improve recovery outcome.

3 Conceptual Model

To sum up, the research model of this study can be found in the Fig. 1.

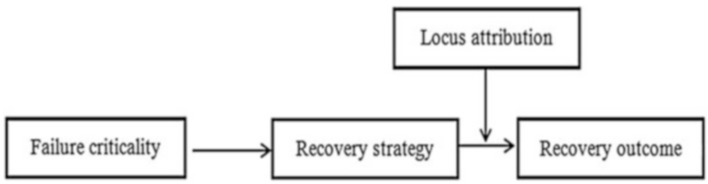

Fig. 1 Research model

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The Research and Application of DMAIC Model in New Student Register System

Hong-na Guo and Jun-ming Zhu

Abstract In view of waiting in line, cumbersome procedure problems existed in the new student register system, the article introduced one of the most advanced six sigma DMAIC models. Through the questionnaire survey and positive Likert scales weighted evaluation method to find out the impact of the main factors and new report quality, presents the improved method. The successful application of the DMAIC model is good for the effective implementation in our universities and further enhance the management level and competitiveness of the colleges and universities. DMAIC model may be extended to railway ticketing system, bank, supermarket and so on.

Keywords DMAIC model • Likert scales • Six sigma • Student register system • 5M1E

1 Introduction

With the increase in Chinese universities and enrollment expansion of the scale, the complex new registration procedure, queuing problems, stand out increasingly. In this paper, DMAIC model of six sigma management is applied to new student register system. Through the questionnaire survey and positive Likert scales weighted evaluation method to find out the main factors of the new report quality.

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Gather information to measure the problems and optimize the registration process of the school management quality, and thus enhance the overall strength and competitiveness.

2 Six Sigma Management DMAIC Model

The “sigma” is the Greek letter “δ” pronunciation, it is quality characteristic value deviating from the normal distribution of average size in statistical (Wang Ying and He Zhen 2007). And six sigma management is modern quality management methods that a set of aims through the application of statistical technology and methods to discover and eliminate the abnormal fluctuations in time, so as to achieve stable quality, reduce costs to enhance customer satisfactions, which advocated by the MOTOROLA United States. Six sigma management ideas began to spread in our country is about late twentieth century. But as an import, the idea of six sigma management is customer as the center, to meet customer expectations as the starting point, to gain customer satisfaction as the end point of the implementation. The management policy in our country is far from western country done well. DMAIC model is the specific implementation of six sigma model (Ma Lin and He Zhen 2011; Schippers 2001). DMAIC is the abbreviations of definition, measure, analyze, improve and control of English first letter. DMAIC improvement model is a logical process of circulation, stressed to customer as the focus, with data to describe the process. The five stages of the model (Wiklund and Wiklund 2002; Zhang Yiyan et al. 2009; Tushman 2006; Zhang Genbao and He Zhen 2010):

A: Define stage: identify the key customers (students) requirements and identify projects or in need of improvement processes, decided to measure, analyze, improve and control the key quality characteristics;
B: Measuring stage: based on the existing measurement and evaluation of the process, formulation of expected target and performance measure, identify influence process output Y, type x_s, and verify the effectiveness of the system (Xu Guoping 2011);
C: Analysis stage: through the data analysis to determine the key factors x_s, and determine the process of the key factors namely;
D: Improvement stage: look for the most improvement program and optimize the process output Y and eliminate or reduce the influence of key x_s, making the process of defect or variation to a minimum;
E: Control stage: to curing of improvement efforts, through qualitative methods such as documents, successful experiences. This stage is also institutionalize the successful experience and further improved method of continuous improvements.

3 DMAIC Model in the New Student Register System

3.1 Define

In DMAIC model, find out the key projects of registration system and key factors affecting the new student register system (Fig. 1).

3.2 Measure

By analyzing the existing defects and shortcomings of new student register system measurement. Identify and quantify key factors of students' satisfaction.

3.2.1 Determine the Level of Satisfaction

In the student satisfaction evaluation, Using likert scale level 5, Satisfaction for level 5: strongly disagree, disagree, generally agree, strongly agree. The score of the question of 1,3,5,9,11,13,14,15 are1,2,3,4,5 from strongly disagree to strongly agree. Question 2,4,6,7,8,10,12,1 are 5, 4, 3, 2, 1 from strongly disagree to strongly agree.

3.2.2 Survey of Students' Satisfaction

(I) Sample selection: The survey for one university students in grade 2009 and 2010. The questionnaire based on degree of satisfaction index system. And it made a classification list from man, machine, method, environment, measurement of all possible factors that influence efficiency. In the early time, 60 questionnaires have been distributed, actual charge 50. In the late, 90 questionnaires distributed, actual charge 86. Calculate the total score of

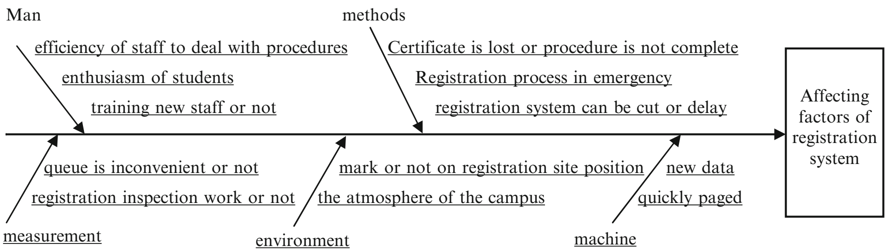

Fig. 1 Affecting the quality of registration fishbone diagram

each questionnaire. Remove the highest and lowest points. Ultimately the real effective questionnaires are 134.

(II) Analysis the data: Statistics each student scores on each of the statements. Using likert scale of the weighted analysis method, calculates each resolution of the problem. For each problem resolution coefficient is K_m, m = 1, 2, …, 15, i = 1, 2, … 35;

Then:

$$K_m = A_{jm} - A_{im}, \quad m = 1, 2, 3 \cdots, 15; \quad j = i + 64 \tag{1}$$

$$A_{im} = \frac{1}{35}\sum_{i=1}^{35} t_{im}, \quad m = 1, 2, 3 \cdots, 15 \tag{2}$$

$$A_{jm} = \frac{1}{35}\sum_{j=99}^{134} t_{jm}, \quad m = 1, 2, 3, \cdots, 15 \tag{3}$$

t_{ij} is the score of questionnaire I, question J.

3.3 Analyze

Statistical analysis of the data collected. Through the Richter scale non-positive feedback from the weighted average method calculates the student satisfaction about the problem. Refer to the detailed calculation process references nine and ten. Using 5M1E (Xu Guoping 2011) classification divides the influencing factors of the new student register system to Man, Method, Measure, Environment, and Machine. According to the degree of satisfaction calculate the satisfaction index, define the weight of each factor and the satisfaction of the students' registration (Table 1). Find the influence factors of high weight, but low student satisfaction to improve.

3.4 Improve

It can be seen from Table 1 that students satisfaction low in Staff is very efficient, Bad weather or not complete procedure terminate registration, waiting no inconvenience to yourself are main factors that influence efficiency of register system. High satisfaction of Registration process leave good impression, Position clear, Route marked. In view of this, hold training for staff in advance and staff should be very familiar with the whole business process of the operation. On the other hand, Preparation of the school must be fully prepared. For example, student

Table 1 The satisfaction of influencing factors about new student system

The first satisfaction index		The secondary satisfaction index	
Man	3.242	New staff lack of enthusiasm	3.729
		All staff through specialized training	2.896
Man–machine efficiency/machine	2.611	Staff is very efficient	2.292
		Payment is not convenient, need to wait in line	3.354
Method	2.315	Bad weather or not complete procedure terminate registration	2.208
		Registration can be cut, in advance or delay	3.417
Environment	3.166	Position clear, route marked	3.542
		Environment comfortable, service good	3.333
		Strong academic atmosphere	3.500
Measurement	3.229	The scene of the staff didn't work	3.258
		Waiting no inconvenience to yourself	2.200
		Registration process leave good impression	3.396

affairs office, security department, logistics department and so on must be worked together. It can be calmly deal with emergency when something emergency happen. In view of register system arrangement, the author thinks that make campus card in advance for those do good for tuition. Other programs allow students to apply later. On the one hand, simplify the registration procedures, improve the working efficiency, on the other hand, also improve the students' ability.

3.5 Control

The main purpose of the control stage is to keep the improvement of the new work flow, avoid suddenly back to the way of old work habits. Control is the key of six sigma management which improves the quality of education for a long time. So, firstly make improvements as the relevant personnel and departments involved to understand and accept this solution, this is the foundation implementary solution; Second, For the new methods, processes, and the definition of the relevant changes should be effectively and form a standardized file; At last, regularly assess the quality improvement program. Analytical tools to assess the quality standard of the new registration system. Quality management master Juran had put forward the famous 20/80 rule (Sheng et al. 2002): All happened quality problems, only 20 %

comes from operating grass-roots level, the remaining 80 % is the management problem. It can be said the school management decides the efficiency of student registration system on a great extent.

4 Conclusion

By analyzing the application of the DMAIC model in the new students register system. There are more researches about six sigma management, such as (De Feo and Bar-El 2002; He and Zhang 2004; He et al. 2004). The author thinks that the focuses for introduce six sigma DMAIC model in colleges or universities are to grasp the idea and essence of six sigma. Under the premise, it can be made up adjustments about its methods and techniques to adapt to the characteristics of the university education quality management. In addition, this article DMAIC model analysis can also be extended to university graduate students registration, student ticket reservation in winter and summer vacation and line up of the bank, supermarkets, etc.

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Valuation of Enterprises Brand Assets Based on Risk Cash Flow

Shi-liang Xia

Abstract Brand valuation has attracted the interest of accounting academicians and practitioners, several valuation methods come into existence, however, after a careful review they prove to be lack of objectivity. We put forward the risk analysis of cash flow method, after an empirical study of the real estate enterprises, it proves to be effective, and moreover, it can meet the demands of objectivity of data processing and direct financial interpretation.

Keywords Brand valuation • Cash flow • Default probability

1 Introduction

As one of the most famous consulting companies, Interbrand valued the Coca cola and Microsoft brand in 2000, and gave the respective price at 72.5 billion dollars and 70.2 billion dollars (Aaker 2002). In 2001 another appraisal company FutureBrand declared that the name of the Real Madrid brand was worth 155 million dollars and the Barcelona brand was worth 85 million dollars. As the first domestic appraised brand, the QingDao Beer was invested as an intangible asset at 200 million (Keller 2003). The year before last year the National Academic Business Research Center, the National Indexes Research Center and the Real Estate Research Center of Tsinghua University set up an appraisal team to evaluate the top ten real estate companies (Perrie 2009), the Vake ranked first with the value of 3.2 billion dollars. When facing with these appraisal results, people may be unconsciously doubted and puzzled, "Are these results reliable? How these results come out?"

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The main problem lying in the assets appraisal process is how to define the brand assets precisely, then accordingly it is hard to point out which part of cash flow can be ascribed to the brand effect, in other words, without the brand, how the cash flow behaves?

As to the brand assets, there are several different understandings as follows: First, brands assets are above the product, the merit of brands assets is beyond the tangible figure (Reilley and Schweihs 2010); Second, brand assets include two elements: brand power and brand value. Brand assets power comes from the potential customers' brand imagination and the delivering channel preferred behavior which creates the long-standing differential strength (Hirose et al. 2009), the brand value matches with the capability which brings forth the owner the present and future income, also cutting down the potential risk. Third, brand assets can be composed of loyalty of brand, quality acknowledgement, identification, imagination and other attached elements (Interband 2004).

Whether the assets appraisal results appear to be reasonable to large extent depends on the appraisal process and the survey system. Since there is no fully accepted definition about the brand assets, many consulting companies (Burgstahler and Dichev 1997), market research companies and appraisal institutes put up with different methods and models, which referred to what W. D. Will had figured out "different persons on different purposes and specific conditions can endow it with different implications and appraisal methods, just like fable the blind touched the elephant".

2 Comparison of Different Brand Assets Appraisal Methods

Although there are now various methods, they can be summed up as follows: based on consumers' recognition, market strength and financial performance. The first category of appraisal model is based on the consumers' recognition whose measurement relies on the consumers' familiarity, intimate attitude, imagination, loyalty to the brand. Many scholars had discussed this methods and which was also performed by many international appraisal institutes. The premise is that the source of the brand strength comes from the intimate relationship between the brand and the customers. Although the final target of marketing is to promote sale scale, the management staff should set up the positive brand recognition in consumes' psychological impression so that the reaction to the specific brand will benefit the particular company (Dechow et al. 1999).

The Chicago Market Facts consulting company creates the "conversion model" which was initially used in religious belief research to judge the psychological contract between the appraised brand and the consumers (Hand and Landsman 1998). The model divides a brand's users into four groups on the basis of the strength of their commitment: unshakable, average, superficial and convertible. It also classifies non –users on the basis of their willingness to try the brand approachable, ambivalent, slightly unapproachable and strongly unapproachable. Market Facts states that the difference between the size of the convertible and approachable segments is a significant indicator of the brand's future health.

As one of the five biggest brand assets appraisal institutes, Young and Rebicam come up with the brand asset valuator model (BAV), whose accuracy depends on the measurement of the brand's vitality and stature. In turn, the brand's vitality can be divided into esteem and familiarity. According to the Young and Rebicam, the fact that a brand is differentiated does not mean that consumers wish to buy it; it must be relevant. A brand has esteem when the customer appreciates its quality. Familiarity is when the consumer knows the brand (Lev and Sougiannis 1996). Both factors must be present for the brand's stature to be high. This method only allows a qualitative valuation of the brand. The advantage of this method is that it can be a good predictive indicator of the brand's potential, however, its shortcoming is its high cost level and it cannot be objective and simple.

The second brand assets appraisal method is based on the market performance of brand. It is believed that the merit of the specific brand assets has something to do with the market strength of the brand directly, so the value should embody on the market performance, such as the high premium of the brand, the high level market takeover. The worldwide famous rank of appraised brands was delivered by the Financial World consulting company annually, the indicators include: the leading power, market stability, internationalized level, sustainable importance of the specific industry, safety of brand possessing, which reflect the brand's market power (Mather and Peasnell 1991).

Compared to first appraisal method, this method can be overall to cover all the aspects of brand performance, it can figure out the sum of the economic value added, since it refers to the comparative data of the different companies. The drawback, however, lies in the dependence on the subjective of consumer's judgments, which seems somehow unfit to the real market consuming occasions. As well, it can make some misleading, for example, many companies of a particular industry may take up high rank of market position, but through the low price or the low cost level, if judged in this way alone, the value will be overestimated.

The third method is based on the financial analysis; the British Interbrand Appraisal Company adopts this appraisal way, the basic idea is that the brand assets will create additional economic income or the present value added. The methods can be classified broadly into cost, market and income approach. The cost approach utilizes the cost spent in developing the brand as a measure of brand value. The market approach also referred as "sales comparison approach", values by making reference to actual price of similar brands traded in market. The income approach, values brands based on the net present value of the excess profit or future cash flows generated by the brand. This kind of methodology can meet the measurable demand, it wants to get the additional cash flow or the economic value added out of the total income, and however, it is difficult to distinguish whether the premium created by the brand or other factors, such as advanced technology, patent or qualified human resources, and so on.

Besides the above three category methods, there are some other appraisal models. The Brand Equity Ten model uses ten indicators including royalty, recognition depth, differentiation, brand imagination and market behavior. The Brand Equity Engine model believes that the value of brand assets does not only depend on the consuming habits of customer crowds but also due to the brand's affinity, so the indicators include the "hard" and "soft" attributes of the appraised brand. In essence, these methods are the compromise of the recognition and the market model.

3 Model of Risk Cash Flow

We suppose cash flow created by brand asset include two parts: one is free of risk, the other part is risky. Since the operating risk is quite different at each operating stage, when we use the single discounted rate to get the final value of brand, there may be quite untruthful. So we imagine that there is a variable X which stands for the minimum cash flow that could be discounted by risk-free rate, the other risky cash flow should also be calculated and its value ranging from [0,q]. If the variable X conform to the random distribution, and we can easily get the cumulative function Fx, We may get the cash flow random variable $Y = x_0 + X$.

But this plan may not be impractical since most financial statements can't meet the precise mathematical requirement of functional description. In order to identify different risk rate of each stage, we suppose the valued brand asset can get through all the pulse of inside and external factors. Let p stand for the variable X which cannot create extra income (if the variable x^0 is 0, it means that the brand asset cannot create cash flow absolutely, and it is common that come up with partial default when the value is above 0). We introduce the auxiliary variable T to describe the discrete distribution, so the probability distribution function can be described as follows:

$$\mathrm{T} \sim \begin{cases} P\,(T = 0) = p \\ P\,(T = 0) = 1 - p \end{cases} \tag{1}$$

We try to get mathematical expectation of variable T and the mathematical expectation of variable X, $E[x^0 + T] = x^0 + E\,[T] = x^0 + E[X] = E[Y]$.

If the accounting period can be divided as unlimited, the value of band asset of particular company can be described as follows:

$$\mathrm{V} = \frac{x^\circ}{r} + \frac{E\,[X]}{r + p} \tag{2}$$

In the Eq. (2), the variable means the risk free rate, and the variable p represents the partial default probability after disturbed by external variables.

At the first accounting period, when the period come to the end, the brand asset owner will get the q cash flow of routine avenue, according to the matching rules of accounting requirements, so we may get the mathematical expectation of the T variables:

$$\mathrm{E}\ [\mathrm{T}_1] = \frac{p.0 + (1-p)\,q}{1+r} = \frac{(1-p)\,q}{1+r} \tag{3}$$

The discounting rate r appears as in Eq. (3), and all the risk factor is consider by the variables denoted by the variable p, if during the first accounting period there is no default events, which means $\mathrm{P}(\mathrm{T}_2 = \mathrm{q}|\mathrm{T}_1 = 0) = 0$ in the second accounting period the brand assets can produce potential avenue continuously.

If there is no default events in the first accounting period, and also the same with the second accounting period, the default probability if P can be described as follows: $\mathrm{P}(\mathrm{T}_2 = \mathrm{q}) = \mathrm{P}(\mathrm{T}_2 = \mathrm{q}|\mathrm{T}_1 = \mathrm{q})\ \mathrm{P}(\mathrm{T}_1 = \mathrm{q}) + \mathrm{P}(\mathrm{T}_2 = \mathrm{q}|\mathrm{T}_1 = 0)\ \mathrm{P}(\mathrm{T}_1 = 0) = (1-\mathrm{p})^2\mathrm{q}$

Then we may get

$$\mathrm{E}\,[\mathrm{T}_2] = \frac{(1-p)^2 q}{(1+r)^2} \tag{4}$$

As to the period n, we can get $\mathrm{E}\,[\mathrm{T}_\mathrm{n}] = \frac{(1-p)^n q}{(1+r)^n}$, so the mathematical expectation of cash flow of brand asset create in the year n

$$\mathrm{E}\,[\mathrm{Y}_\mathrm{n}] = \frac{x^\circ}{(1+r)^n} + \frac{(1-p)^n q}{(1+r)^n} \tag{5}$$

so, the cumulative sum of cash flow we may get:

$$\mathrm{V} = \sum_{n=1}^{\infty} E\,[Yn] = \sum_{n=1}^{\infty} \frac{x^\circ}{(1+r)^n} + \sum_{n=1}^{\infty} \frac{(1-p)^n q}{(1+r)^n} \tag{6}$$

Then, $\mathrm{E}\,[\mathrm{T}] = \mathrm{E}\,[\mathrm{X}] \Rightarrow (1-\mathrm{p})\,\mathrm{q} = \mathrm{E}\,[\mathrm{X}] \Rightarrow \mathrm{p} = 1 - \frac{E[X]}{q}$, E[X] stands for the mathematical expectation of cash flow produced by brand asset, and variable q stands for the maximum mathematical value of cash flow, so we can use the financial data from financial balance sheet to calculate the brand asset, and the Eq. (2) can reveal the risk pattern of the brand assets.

4 Conclusions and the Further Research of Brand Assets Pricing

First, the pricing of a specific brand will pay more attention to the appraisal enterprises, when we want to value the brand assets we will focus on the stable capacity of winning the sustainable cash flow. With the brand strategy more and more prevalent, many brand transactions will take place. When valuing the brands, we should notice whether the owner has changed. As to the merge of the IBM and the Legend Group Corporation, there is a dispute about the success of Legend's personal computers market regeneration.

Second, the appraisal activities will be more clearly pointed out "when and why". The appraisal results will have something to do with the appraisal purpose. The value of the initial investment will even seem too little comparing to exchange value.

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Application of DMAIC Method and Discrete Event Simulation to Reduce Waiting Time in Outpatient Department

Xing Gao and Wen-ying Zhou

Abstract The outpatient departments of hospitals in large cities have become more and more congested in recent years. Patients often spend excessively long time waiting during the whole outpatient procedure, which lowers the degree of patient satisfaction and increases patient complains about the outpatient service. This Paper utilizes the simulation-based Six Sigma DMAIC method to identify the defects of existing procedure in outpatient department of a general hospital in Tianjin and to propose solutions to ameliorate the outpatient procedure. Using software package named iGrafx IDEF0 2011 and relevant data, the existing outpatient procedure simulation model is constructed and validated. After analysis, defects behind the long waiting time are identified and several improvement scenarios are proposed. The improved simulation model which has implemented these scenarios shows that new outpatient procedure significantly reduces overall waiting time compared with the original one.

Keywords DMAIC • Discrete event simulation • Outpatient waiting time • Six Sigma

1 Introduction

Due to the growing demand for healthcare services from citizens, general hospitals are experiencing increased pressure to advance the level of service quality provided to patients (Silvester et al. 2004). The outpatient department, which is known as the core facility to provide diagnoses and treatments for patients, has become more and more congested in recent years. In the absence of an optimized outpatient procedure,

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patients have to spend excessively long time waiting during the whole process, which results in patient dissatisfaction and complains about the hospital.

Key care dimensions, which judged by patients, include accessibility, timeliness and effectiveness. To achieve maximum patient satisfaction and to upgrade competitive edge, outpatient department have to implement strategies to decrease waiting time and increase service efficiency and quality.

Since the employment in the manufacturing sector by Motorola Inc. in 1987, Six Sigma has been introduced in more and more industries, which brought about significant quality improvement and competitive edge rise for these enterprises. Six Sigma is a methodology which uses statistical analyses to measure and reveal opportunities for process improvement by uncovering defects (Lucas 2002). Since Six Sigma has received wide acclaim as a valid method for process design and quality improvement, healthcare organizations have started implementing Six Sigma methodology to elevate service performance and satisfy patient needs. Mari designed an equipment depot at the Greenfield hospital by using Six Sigma methodology (Mari 2007). Hsi-Chin Chen et al. introduced the Six Sigma DMAIC methodology to enhance the health benefit of the nursing and caring institution (Hsi-Chin Chen et al. 2011).

The DMAIC technique, deployed via a framework of phases known as Define, Measure, Analyze, Improve and Control, is the most prevalent Six Sigma method used for process improvement (de Mast and Bisgaard 2007). This Paper utilizes the DMAIC method of Six Sigma to identify the defects behind existing procedure in outpatient department and to propose solutions to ameliorate outpatient procedure.

While both customers and administrators of the organization have acknowledged the necessity to advance the level of service performance, it is expensive and difficult to test all the possible management changes in real system. Considering the complexity and uncertainties of the process, discrete event simulation is often used for experimental design and predicting system performance in Six Sigma methodology, serving as an effective platform for DMAIC deployment.

On the one hand, discrete event simulation can present the dynamic and complex nature of outpatient process and test the effects of different management changes. Aharonson-Daniel et al. applied simulation models in queue management in outpatient clinics (Aharonson-Daniel et al. 1996). Fetter and Thompson studied the effects of patient and consultant punctuality on an outpatient clinic using a simulation model (Fetter and Thompson 1966). On the other hand, through DMAIC method, researchers can conduct simulation study with more reliable information, accurate flow chart and a structured approach for analysis and improvement. Thus, the simulation-based DAMIC approach reduces time and cost of physical experimentation and provides a visual method to validate tested scenarios (Al-Aomar 2007). In this paper, discrete event simulation model is built using software package named iGrafx IDEF0 2011, which is specifically designed for process analysis and simulation. Moreover, the simulation models have been verified and validated by the collected data and detailed analysis in DMAIC.

The study of this paper aimed at reducing waiting time of outpatient procedure through the simulation-based DAMIC approach. The method and model section is organized in the sequence of DMAIC elements, including the five phases named

Define, Measure, Analyze, Improve and Control. The existing patients flow in the outpatient department of a local hospital is given in the Define phase. Then the Measure phase explains the method of data collection. Using iGrafx software, the existing outpatient procedure simulation model is constructed and validated, and defects behind waiting time are identified in the Analyze phase. The Improve phase proposed several improvement scenarios to minimize the detected causes and implemented them in the new discrete event simulation of outpatient procedure. The improved model simulation results show that new outpatient procedure significantly reduces waiting time compared with the original one. The Control phase introduces some continuously monitoring standard to reinforce the performance of improvement. The final section provides the conclusion of the study.

2 Method and Model

DMAIC method of Six Sigma includes five phases known as Define, Measure, Analyze, Improve and Control. The five phases will be used throughout the study to redesign the outpatient procedure to improve the performance of the outpatient department of a general hospital in Tianjin and to reach the ultimate goal of customer satisfaction. This section describes the DMAIC phases in detail.

2.1 The Define Phase

The first phase of DMAIC is Define, which defines the object process to improve and the critical to quality (CTQ) factor to study. Since study in this paper is focused on the outpatient department of a general hospital in Tianjin, the outpatient procedure in this hospital is recorded and illustrated in Fig. 1.

As shown in the Fig. 1, the main steps, including registration, consultation, lab test, getting medicine and payment, compose the outpatient procedure in this hospital and each step requests the patient to wait in a queue.

When the patient arrives at the outpatient hall, he/she gets a queue number and waits for registration. When his/her number is called, the patient registers at the registration counter. After that, the patient goes to the specific consulting area and waits for his/her first consultation. When his/her name is called, the patient enters the consulting room and consults the doctor. If the doctor confirms that the patient is healthy and unnecessary to take any lab test or medication treatment, the patient ends his/her visit and leave the hospital. Otherwise the doctor decides whether the patient needs some lab tests. If the doctor only request some medication treatment without any lab test about the patient, the patient then return to the outpatient hall. He/she gets a new number and waits for paying for the medicine. After the payment, the patient goes to the pharmacy and stands in the queue to waiting for getting medicine. Finally, the patient finishes his/her visit after getting the medicine. If lab

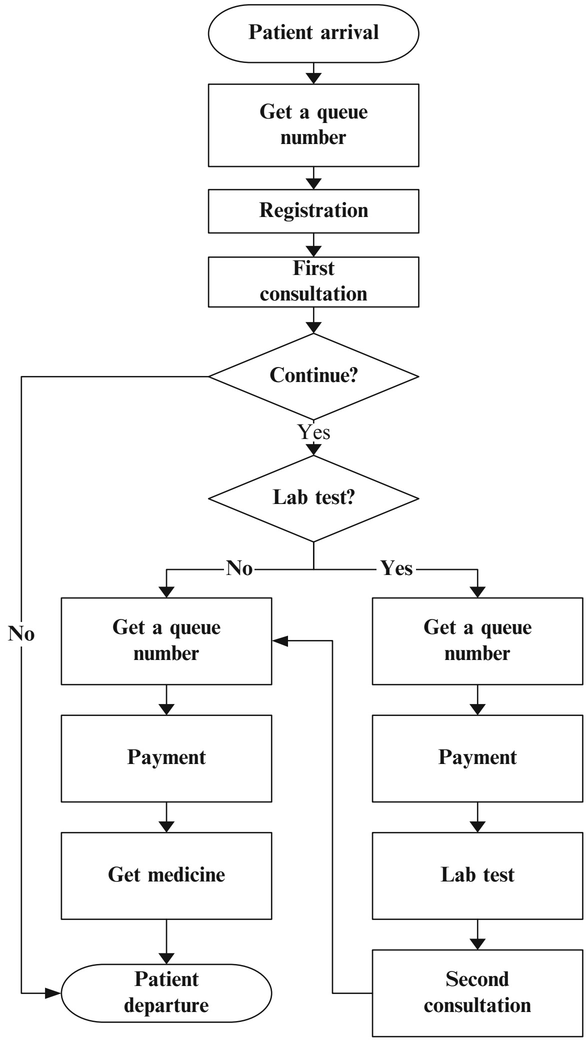

Fig. 1 Existing outpatient procedure of studied hospital

test is requested, the patient goes back to the outpatient hall to pay for the lab test and then wait in the lab test department until he/she is called in to take the test. Once the test has finished and the result has been printed out, the patient returns to the previous consulting area with the result and waits for his/her second consultation. After the second consultation, the patient pays for the medication treatment and gets medicine as the procedure described above.

Any defect in the whole process, as viewed by the customer, may lead to dissatisfaction (Dreachslin and Lee 2007). Since the goal of DMAIC is to detect defects and to upgrade the level of quality, a patient satisfaction survey is useful to define the critical quality (CTQ) factor, which one that patients most care about in this service process. A relevant survey which was distributed to a random sample of patients visiting this outpatient department revealed that most patients were dissatisfied with the long waiting time in the whole outpatient procedure. Therefore, the patient CTQ factor is the overall waiting time.

2.2 The Measure Phase

The task in the measure phase is to identify and collect the relevant data needed in study. Measures should encompass outputs and inputs, because input data is used as parameters for the constructing the simulation model, while the output data serves for validating the model.

Data needed in this study can be divided into two groups, the input group and the output group. The data of input group contains number of patient arrival per minute, number of all the resource involved in the process including the number generating machine, registration windows, payment windows, doctors, lab test rooms and pharmacy windows, and service times of each step, including the time for getting a queue number from the number generating machine, service time of registration, duration of consultation, service time of payment, duration of lab test and service time of getting medicine. The data of output group contains duration of waiting for each main step including registration, consultation, payment, lab test and getting medicine. A 4-week survey was conducted in this outpatient department to collect data needed in this study.

2.3 The Analyze Phase

Data analysis and simulation model for existing outpatient procedure are conducted and validated in this phase. Based on the data collected, the ratio of patient flow to different clinical consulting room and the ratio of patient flow to different lab test rooms are conclude. Then value or distribution of each input parameter is obtained and the reliability of each parameter is verified by the statistics software SPSS and Minitab.

Patient arrival pattern follows Poisson distribution which shows 2.49 patients arrive averagely per minute. The service time in registration, payment, lab test and pharmacy all follow normal distribution. The service time in consultation is exponential distributed, while second consultation time is uniform distributed. Getting a queue number for registration takes only 3 s based on time and motion study.

After data analysis, simulation model as shown in Fig. 2 was built with iGrafx. This simulation model aims at understanding the performance of the current state of the hospital and to investigate potential improvement scenarios (Al-Araidah et al. 2012).

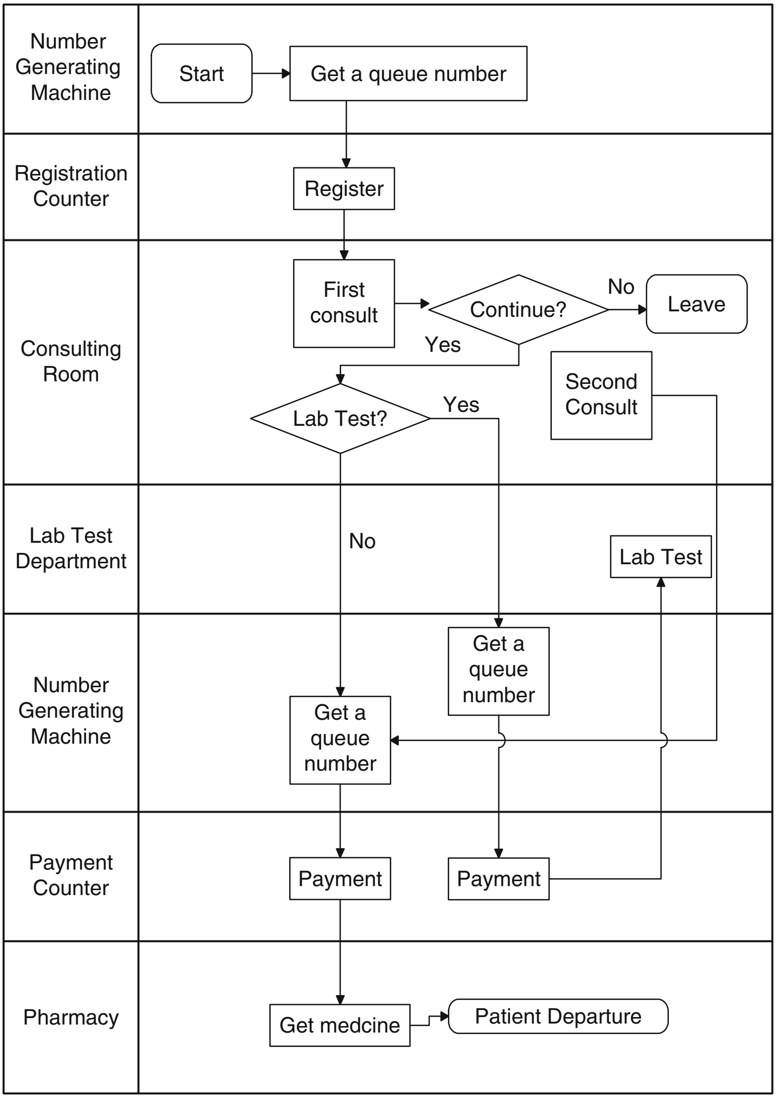

Fig. 2 Existing outpatient procedure simulation model

The model ran for 20 times of 7 h long which is a replication represents one workday to show the current state of performance of outpatient procedure in this hospital and the relevant results were accumulated for statistical summary which mimic the behavior of the system.

The comparison of simulation results and the measured data as shown in Table 1 validated reliability of the model. The data of real waiting time derived from the measure phase, and indeed the data of patient waiting time in each outpatient step

Table 1 Comparison of simulation results and measured results for patient waiting time of existing outpatient procedure

Waiting type	Simulation results	Measured results
Getting a queue number	0.47	0.54
Registration	11.91	10.65
Consultation	23.46	25.84
Lab test	15.11	13.08
Payment	18.19	16.90
For medicine	6.70	7.53

Table 2 Detailed simulation results for existing outpatient procedure

Procedure	Count	Average cycle time	Average serve time	Average waiting time
Registration	753	13.08	1.17	11.91
Consultation	753	35.07	11.61	23.46
Lab test	289	27.99	12.88	15.11
Payment	533	19.99	1.80	18.19
Get medicine	533	8.19	1.49	6.70
Sum	753	79.42	20.16	59.26

collected from the model were found to be similar to those observed in the hospital. Therefore, the model was verified to be reliable for simulation and defects in existing procedure can be found from the simulation results.

Table 2 shows detailed simulation results for each step of existing outpatient procedure. According to the data in Table 2, each patient spends 79.42 min on average during the whole outpatient process (walking time not included) while 59.26 min averagely was spent on waiting. Results indicate that patients have to spend long time waiting for outpatient services and the three longest waiting periods exist in registration, consultation and payment. Thus, long waiting time of these three steps can be considered as defects in the existing outpatient procedure.

2.4 The Improve Phase

According to the defects in outpatient procedure, following improvement scenarios are proposed to minimize the detected causes.

Firstly, it is necessary to reduce the time waiting for registration. By automatic registration, the efficiency of registration will be improved. Automatic registration machine takes patient only 10 s averagely to register based on time and motion study. In order to control the cost of new equipment, according to trials of simulation, adding just one automatic registration machine is suitable.

Secondly, information system such as pharmacy information system and lab test information system can be applied to outpatient process to reduce the unnecessary patient waiting and moving and to avoid transcription errors (Zhan et al. 2006).

Table 3 Detailed simulation results for existing outpatient procedure

Procedure	Count	Average cycle time	Average serve time	Average waiting time
Registration	401	2.59	1.17	1.42
Automatic registration	442	8.41	0.67	7.74
Consultation	843	40.55	13.05	27.50
Lab test	335	40.91	12.78	28.14
Get medicine	612	0.19	0.17	0.02
Sum	843	62.77	19.28	43.49

Prescribe can be transmitted immediately to the pharmacy through information system to reducing time waiting for medicine preparation. When the patient arrives at pharmacy, the medicine is already packaged with instructions (Levy et al. 2011). By the lab test information system, results of lab test can be sent to the doctor's computer directly, reducing the time of patient waiting for the printing of results.

Thirdly, to decreasing waiting time for payment, the rechargeable-prepaid medical card can be promoted in the outpatient department. After recharging the medical card, patient can pay the fee of medicine or lab test directly with the medical card at the consulting room and patient no longer need to waiting for payment.

Fourthly, the number of doctor should be increased to decrease the waiting time for consultation. Trials of simulation can help to determine the most suitable increased number of doctors. By results of simulation, we found four extra doctors can keep the highest output-input ratio.

All the four improvement scenarios mentioned above were implemented in the new outpatient procedure and improved discrete event simulation model as shown in Fig. 3 was built (Zhecheng Zhu et al. 2012).

The patient registers and recharges the medical card at manual registration counter or automatic registration upon arrival. When his/her number is called, he/she enters the consulting room to consult with the doctor. If the doctor does not request extra lab tests, the patient pays for medicine there, and then goes pharmacy for medicine. If extra lab tests are requested, the patient pays for lab test there and then proceed to lab test department. When the test results are transmitted to the doctor and the doctor is available, the patient is called for second consultation. After that, the patient pays for medicine and gets his/her medicine at pharmacy. After getting medicine, if the patient wants to take the remaining money, he/she can get the money at registration counter. Besides, the remaining money can be used for next treatment.

The improved model also ran for 20 times and Table 3 shows the results of average performance in outpatient procedure on each workday. From comparison of Tables 2 and 3, the effects of improvement scenarios are demonstrated.

On the one hand, since the payment step is significantly simplified, the cycle outpatient procedure time decreases from 79.42 to 62.77 min, decreased by 20.96 %. Moreover, average overall patient waiting time reduced by 26.61 %, from 59.26 to 43.49 min.

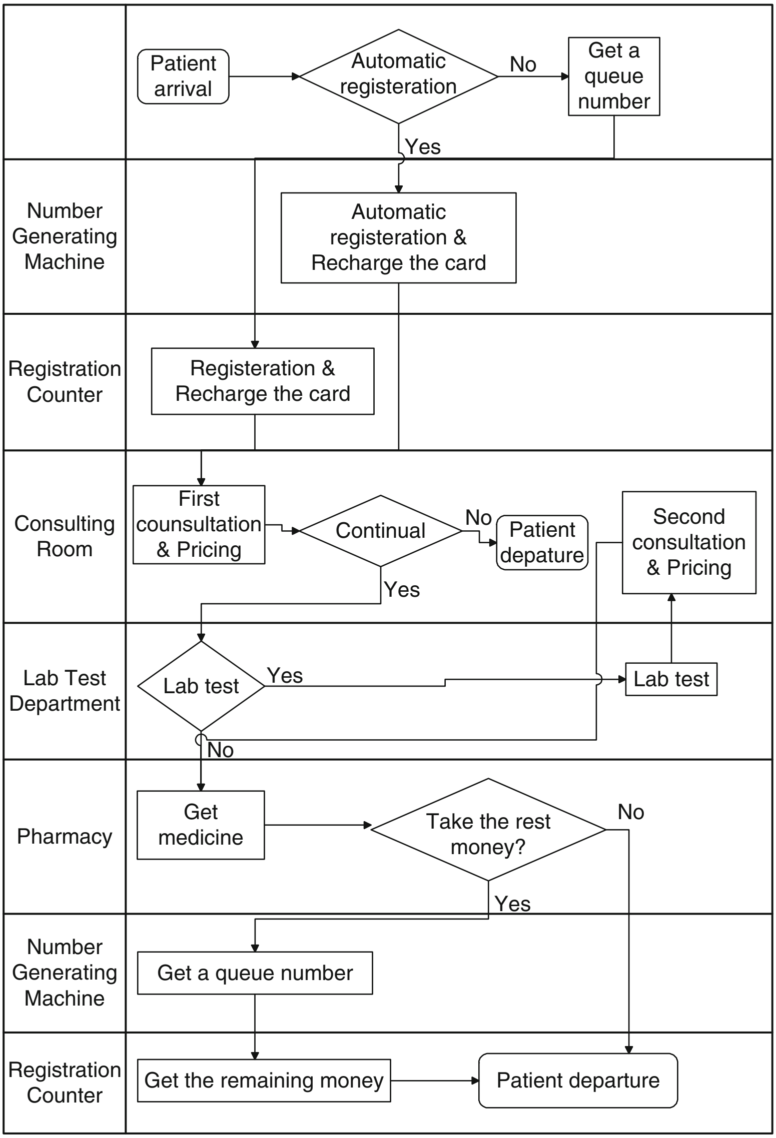

Fig. 3 Improved outpatient procedure simulation model

One the other hand, the new outpatient procedure can treat more patients. The number of patients treated per day increased from 753 to 843, while the number of doctors increased only four.

2.5 The Control Phase

The last phase of DMAIC is control. The primary task for control phase is to monitor the status of the improvements of the process and to maintain the gains described in the improve phase (Kumar and McKewan 2011). Therefore, operators should examine the changes of waiting time in real implement of the new outpatient procedure. In addition, as the inherent concept of Six Sigma is continuous improvement, new possibilities for further improvement are detected in this phase (Kovach et al. 2008). The executive officer of the hospital should focus on the voice of patient all along to tackle the problems with concrete improving strategy proposed, whereby to effectively control the quality of performance of outpatient service, further to upgrade patient satisfaction and the competitive edge of the hospital.

3 Conclusion

The study in this paper employed simulation-based DMAIC method of Six Sigma to ameliorate the outpatient procedure of a general hospital in Tianjin. According to the survey, patient flow and relevant data, patient waiting time in the whole outpatient procedure was defined as the critical to quality (CTQ) factor. The existing outpatient procedure simulation model was developed, verified, and validated using iGrafx IDEF0 2011. Analysis was conducted to detect defects behind the existing outpatient procedure. Several improvement scenarios are proposed based on the detected causes. An ameliorated outpatient procedure simulation model which integrated those improvement scenarios was constructed and tested. Simulation results indicated significant improvement in outpatient department performance if the new procedure can be implemented, which demonstrated that number of patients treated in this outpatient department per day can averagely increase by 90 as well as waiting time in the whole outpatient procedure can averagely decrease by 26.61 %.

The study illustrates the usability of Six Sigma DMAIC method and discrete event simulation in improving the performance of outpatient department. Moreover, approach in this study can be generalized to ameliorate more healthcare services.

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Application to Car Quality Evaluation Using Decision Tree Technology with Imbalance Correction Coefficient

Hao-yu Wang, Chang-an Liu, Shu-juan Wang, and Yan Li

Abstract In order to realize the intellectualized quality evaluation, a new decision tree method is utilized into quality evaluation system of production. A new impurity measure is proposed to make the method focusing on the variable which stimulated the interest of customers, which forms the basis of the algorithm. The new algorithm was tested on various datasets related to quality evaluation and quality prediction. The obtained results have been compared to other methods, indicating the superiority in accuracy and computation cost of the proposed method. Based on the evaluation results from the cars, the new decision tree method excels at the common tasks of classification and evaluation.

Keywords Decision tree • Imbalance class • Quality data • Quality evaluation

1 Introduction

Quality evaluation is one of critical techniques in concurrent design process, which are the key technologies to improve the reliability of complicated equipments. In modern manufacturing industry, Data which contain quality information are collected in multiple aspects. Available patterns can be observed in manufacturing process to improve quality and production efficiency by using data mining algorithm (Sadoyan et al. 2006), the most typical case is the research on quality control (Choudhary et al. 2009): quality traceability, prediction (Chengjie et al. 2011), quality evaluation and fault diagnosis (Habib and Rokonuzzaman 2011). The accuracy and timeliness of quality improvement are directly affected by the data

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mining algorithm. This paper focuses on proposing a reliable classification model to predict and evaluate product quality, which can process quality-related data in manufacturing pertinently and efficiently.

2 The Deficiency of Traditional Data Mining Methods in Quality Data Processing

Quality data in manufacturing process involves in all aspects, such as supplier list, the specifications of standard parts, machine model, machining process, product model and the environment (pressure, temperature, etc.). The Characteristics of quality data are as follows:

1. Widespread Resources: Quality data comes from the records of processing information in each workshop and department.
2. Variant Format: Quality data obtained from PDM system contains Bill of Material (BOM), technology documents, etc.
3. Missing Value: the lack of quality data is caused by the loss of design information and the omission of operation record constantly.

Since the quality data accumulated in a manufacturing company has unique characteristics, the reasons that conventional classification algorithms are ineffective in processing these data can be attribute to three effects:

1. "Multi-Type": Quality data stored in database is multi-typed, including binary attributes, nominal attributes and continuous attributes.
2. "Class Imbalance Problem (Hoens et al. 2012)": Imbalanced class distributions in data base are commonly been seen in the situation of inspection and quality detection.
3. "The Curse of Dimensionality": There are many attributes related to quality in a manufacturing enterprise database. The increase in dimensionality of the data compounds the analysis difficulty.

Adapting to the characteristics of quality data, decision tree is more appropriate for quality data analysis. Firstly, decision tree can process both numeric and non-numeric data at the same time, which reduce data preprocessing time by comparing with ANN. Secondly, it is easy to interpret and quite robust to the interference of noise. Thirdly, the accuracy of decision trees is not adversely affected by redundant attributes (Albisua et al. 2011). The decision tree method (such as C4.5, ID3) is a predictive modeling technique widely used in classification and prediction tasks. But decision tree exist limitation to solve class imbalance problem (Ramanan et al. 2007). First, Impurity measure like gain ratio inclines to a maximum global accuracy. Second, instances of the rare class would be deleted by pruning.

So the consequence is that information gain depends crucially on the precision of majority class to maximize the global accuracy, while the rare class has been neglected. A classifier processing with quality data should balance precision against recall, which the traditional data mining methods are not good at it.

3 Class Imbalance Correction Coefficient (ICC)

In imbalanced data sets, accuracy measure may not be suitable because the rare class is considered more important than the majority one (Alibeigi et al. 2012). For binary classification, positive class (class y) represents the rare class, while negative class (class $-y$) represents the majority class. X is the sample data from rare class and $-X$ is the sample data from majority class. A confusion matrix that summarizes classification result is shown in Table 1.

Precision (P) and recall (R) are two performance measures in class imbalance problem. These metrics are defined as:

$$p = \frac{TP}{TP + FP}. \tag{1}$$

$$r = \frac{TP}{TP + FN} \tag{2}$$

Usually there is a tradeoff between the precision and the recall. The F_β-measure which represents the tradeoff between precision and recall is defined as:

$$F_\beta = \frac{\left(\beta^2 + 1\right) rp}{r + \beta^2 p} \tag{3}$$

Both precision and recall are special cases of F_β by setting $\beta = 0$ and $\beta = \infty$. Low values of β make closer to precision, while high values make it close to recall.

In order to weight rare class and the major class and make tradeoff between the precision and the recall, using information from Table 1, an Imbalance Correction Coefficient (ICC), is defined as:

$$ICC = -\log\left(\frac{TP + FN}{FP + TN}\right) \tag{4}$$

where (TP + FN)/(FP + TN) represents the ratio of rare class instances to major class instances (TP + FN < FP + TN). The characteristic of ICC is shown in Fig. 1. (TP + FN)/(FP + TN) is plotted on the X-axis and the ICC is plotted on the Y-axis.

ICC is created based on the F_β-measure. Replace β with ICC:

$$F_{ICC} = \frac{\left(ICC^2 + 1\right) rp}{r + ICC^2 p} \tag{5}$$

Table 1 A confusion matrix for a binary classification with imbalanced data

		Predicted class		
		y	$-y$	Σ instances
Actual class	X	True positive (TP): a	False negative (FN): b	a + b
	−X	False positive (FP): c	True negative (TN): d	c + d
Σ instances		a + c	b + d	

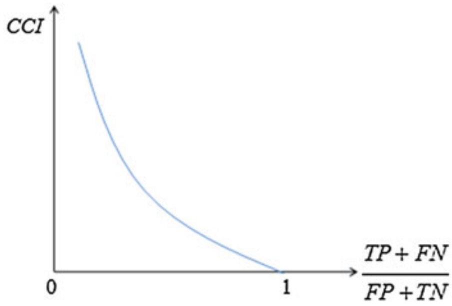

Fig. 1 Phases of quality control process with FCPDT

The F_β-measure transform into F_{ICC}-measure, which could evaluate the classifier easily.

Based on the F_{ICC}-measure, a new decision tree is proposed which is robust in the imbalance class problem and suitable for quality data mining.

4 FCP-Based Decision Tree (FCPDT) Using ICC

4.1 F_β-Measure Confidence Proportion

In order to process rare class data precisely, a new impurity measure based on F_{ICC}-measure is presented to replaces that of C4.5. A new concept of F_{ICC}-measure Confidence (FC) is defined as:

$$\begin{cases} FC(X \to y) = \dfrac{\left(ICC^2 + 1\right) P(X \to y)\, R(X \to y)}{R(X \to y) + ICC^2 P(X \to y)} \\ FC(X \to -y) = \dfrac{\left(ICC^2 + 1\right) P(X \to -y)\, R(X \to -y)}{R(X \to -y) + ICC^2 P(X \to -y)} \end{cases} \tag{6}$$

where $P(X \to y)$ equals to $TP/(TP + FP)$. $R(X \to y)$ equals to $TP/(TP + FN)$ Similarly, $P(X \to -y)$ and $R(X \to -y)$ correspond to $FN/(FN + TN)$ and $FN/(TP + FN)$.

Apparently, FC takes recall into consideration while C4.5 simply focuses on precision. FC similar to F_{ICC}-measure can reduce the influence of data imbalances by adjusting the value of ICC: low values of ICC make closer to precision, while high values make it close to recall. The proportion of the FC in one split is proposed to guarantee accuracy. The FC *Proportion* (FCP) is defined as:

$$\begin{cases} FCP(X \to y) = \dfrac{FC(X \to y)}{FC(X \to y) + FC(X \to -y)} \\ FCP(X \to -y) = \dfrac{FC(X \to -y)}{FC(X \to y) + FC(X \to -y)} \end{cases} \tag{7}$$

FCP is the ratio of FC in rare class to that of all classes, a qualified classifier should maximize $FCP(X \rightarrow y)$ and minimize $FCP(X \rightarrow -y)$. Similar to C4.5, the entropy of each tree node is defined as:

$$\begin{aligned} Entropy_F(t) = & -FCP(X \rightarrow y)\log_2 FCP(X \rightarrow y) \\ & - FCP(X \rightarrow -y)\log_2 FCP(X \rightarrow -y) \end{aligned} \tag{8}$$

Gain ratio act as evaluation criteria in the decision tree (Hongyan 2012):

$$Gain\ ratio = \frac{\Delta_{info_F}}{Split\ Info} \tag{9}$$

where $\Delta_{info_F} = Entropy_F(t) - \sum_{i=1}^{k} \frac{n_i}{n} Entropy_F(i)$, and $Split\ Info = -\sum_{i=1}^{k} P(v_i)$ $\log_2 P(v_i)$ and k is the total number of splits.

4.2 FCPDT Algorithm Description

A FCP-based decision tree can be formulated by replacing gain ratio in C4.5 with (9). The process of creating FCP-based decision is described in Table 2. The algorithm builds a decision tree by recursively choosing the best attribute to split based on the ICC value (Steps 6 and 7) and creating internal nodes (Steps 9, 10 and 11). A leaf node will be created (Step 2) if the instances in tree node meet the stopping criterion (Step 1).

The BestSplit () function in Table 2 determines which attribute should be split by comparing the value of impurity measure in each attribute, which is expounded in previous session.

5 Experiments

5.1 Comparison on Algorithms

To evaluate the performance of FCPDT with ICC in quality data mining problems, a comparative experiment was conducted on nine datasets related to quality evaluation and quality prediction from the UCI repository, which contain both balanced and imbalanced datasets. The information of each data set is shown in Table 3.

FCPDT with ICC is compared with C4.5 and CCPDT (Liu et al. 2010) on binary class datasets. All experiments were carried out using two folds cross validation. Many techniques have been proposed to alleviate the problem of class unbalance by using data preprocessing technique (Christa et al. 2013). Two such techniques are data sampling and boosting (Satuluri and Kuppa 2012). Data sampling balances the

Table 2 FCP-based decision tree algorithm

Algorithm (CreatTreeNode) Creation of FCP-based decision

Input: Training Data Set: *TDS*
Output: FPCDT
if All instances have the same class label **then**
$leaf = rootNode$
$leaf.label =$ instances' class
return *leaf*
Else
Calculate the ICC in this node
$Attri =$ BestSplit(TDS)
$rootNode.label = Attri$
for each value v_i of Attri **do**
  create new *treeNode*
  if no instance with value v_i **then**
    $Leaf = treeNode$
  else
    $treeNode =$ CreatTreeNode(instances in v_i)
    $rootNode.childnode = treeNode$
  end if
end for
end if
return decision tree

Table 3 The information of each dataset from the UCI repository

Data sets	Instances	Attributes	MinClass (%)	ICC
Balance scale	1,250	4	49.0	0.017
Crx	6,906	15	44.5	0.095
Nursery	12,960	8	31.2	0.343
Haberman's survival	3,066	4	26.5	0.443
Adult	8,141	7	23.5	0.515
Connect_4	675,576	42	24.1	0.498
CMC	14,736	10	22.7	0.532
Insurance	9,822	86	6.9	1.130
Mechanical analysis	2,096	7	2.9	1.524

class distribution in the training data by either adding examples to the rarely class (over-sampling) or removing examples from the majority class (under-sampling). However, both under-sampling and oversampling have their respective advantages and disadvantages. The main disadvantage of under-sampling (Weiss 2004) is the loss of information that comes with deleting examples from the training data and the time consuming (Batista et al. 2004). Several researchers have shown that Random-SMOTE (Yangjie and Xuehua 2011), LS-SVM (Brown and Mues 2012) can be appropriate for imbalanced datasets. However, none of them were used in the experiments in order to observe difference in splitting criteria clearly. Table 4 lists the comparison between each classifier with accuracy and the count of tree nodes.

Table 4 Accuracy and nodes comparisons of classifiers on various data sets

	C4.5				CCPDT				FCPDT with ICC			
Data sets	Accuracy (%)	Recall	F-measure	Nods	Accuracy (%)	Recall	F-measure	Nods	Accuracy (%)	Recall	F-measure	Nods
Balanced	83.3	0.938	0.834	92	84.8	0.925	0.865	146	83.8	0.951	0.839	36
Min Class >20 %	74.2	0.940	0.752	25	74.2	0.930	0.769	27	75.0	0.940	0.769	15
Min Class <10 %	93.8	0.008	0.016	274	84.2	0.923	0.313	83	84.1	0.948	0.358	64

Table 5 The example of evaluation records

No.	Buying	Maintenance	Doors	Persons	Lug_boot	Safety	Class
1	vhigh	vhigh	2	2	small	High	uacc
2	vhigh	high	2	2	large	med	acc
3	vhigh	vhigh	4	2	small	high	uacc
4	high	med	2	2	large	high	acc
5	vhigh	vhigh	2	4	large	low	uacc
6	med	med	4	2	small	med	acc
7	med	low	4	4	small	low	uacc
8	vhigh	vhigh	2	2	med	med	acc
9	vhigh	high	2	2	small	low	uacc
10	high	high	2	2	med	low	uacc
11	high	high	4	2	med	high	acc
12	high	med	2	4	small	low	acc
13	high	high	4	2	small	low	uacc
14	vhigh	vhigh	2	2	small	low	uacc
15	med	low	2	2	large	med	acc

According to the Table 4, FCPDT with ICC had significantly smaller size (the number of tree nodes) than C4.5 and CCPDT while the accuracy remained unchanged by contrasting these methods, which would be clearly observed in balanced data sets. The accuracy of FCPDT was consistent with CCPDT and appreciably lower than that of C4.5 in processing imbalanced data (Min Class <10 %). But the FCPDT obtained the highest recall and F-measure (0.948 of recall and 0.358 of F-measure), which were significantly higher than that of C4.5 (0.008 of recall and 0.016 of F-measure, indicated that C4.5 failed to classify instances in rare class) and CCPDT (0.923 of recall and 0.313 of recall), demonstrated that the classifier recognized the majority instances of rare class correctly. The experiment showed that FCPDT had reached the anticipated request.

5.2 Application of FCPDT in Car Evaluation

In this experiment, FCPDT with ICC was applied to car evaluation. Since FCPDT is suitable for quality data processing, it will be a reasonable and practical option to make use of FCPDT for car evaluation.

In order to predict customer's choices, a set of process inspection records was analyzed. The training data set includes 944 records. Each record has 14 input attributes representing car performance. Most of the parameters fall into one of the following classes: price, maintenance cost, number of doors, capacity in terms of persons to carry, the size of luggage boot and estimated safety of the car, which is partly list in Table 5 ("buying" represents for the price, "Maintenance" represents the cost of the maintenance, Lug_boot represents the size of luggage boot).

The processing result from FCPDT is represented in Fig. 2. From Fig. 2, 25 leaf nodes were established. Class label (acc/unacc) of leaf node depended on the

```
RootNode instances:
|       buying=vhigh:
|       |       lug_boot=small: 6/72 <Class=unacc>
|       |       lug_boot=med:
|       |       |       doors=4: 8/20 <Class=acc>
|       |       |       doors=2: 4/62 <Class=unacc>
|       |       lug_boot=big:
|       |       |       maintenance=med: 3/5 <Class=acc>
|       |       |       maintenance=low: 3/5 <Class=acc>
|       |       |       maintenance=high: 0/20 <Class=unacc>
|       |       |       maintenance=vhigh: 10/42 <Class=unacc>
|       buying=high:
|       |       lug_boot=small: 9/72 <Class=unacc>
|       |       lug_boot=med:
|       |       |       doors=4: 10/20 <Class=acc>
|       |       |       doors=2: 8/52 <Class=unacc>
|       |       lug_boot=big: 24/72 <Class=acc>
|       buying=med:
|       |       maintenance=vhigh: 10/54 <Class=unacc>
|       |       maintenance=high:
|       |       |       lug_boot=small: 10/18 <Class=acc>
|       |       |       lug_boot=med: 3/18 <Class=unacc>
|       |       |       lug_boot=large: 4/18 <Class=unacc>
|       |       maintenance=med:
|       |       |       doors=4: 7/18 <Class=acc>
|       |       |       doors=2: 9/52 <Class=unacc>
|       |       maintenance=low: 6/54 <Class=unacc>
|       buying=low:
|       |       maintenance=vhigh: 10/54 <Class=unacc>
|       |       maintenance=high: 16/54 <Class=unacc>
|       |       |       lug_boot=small: 9/18 <Class=acc>
|       |       |       lug_boot=med: 5/18 <Class=unacc>
|       |       |       lug_boot=large: 2/18 <Class=unacc>
|       |       maintenance=mid: 6/54 <Class=unacc>
|       |       maintenance=low: 6/54 <Class=unacc>
```

Fig. 2 Decision tree obtained by FCPDT with ICC

proportion of accept instances, eight leaf nodes were labeled with "acc" and rest of them were labeled with "unacc" (threshold: accept instances >30%). Nine decision rules are generated for the car evaluation classification as shown in Table 6.

Based on the analysis result, it can be inferred from decision rules that the customers tend to a car with big luggage boot and four doors. By using this method, we can find more potential rules hidden behind and give advice to the product design and development.

6 Conclusion

In this paper, the problem that conventional data mining methods were inapplicable to quality data in manufacturing was analyzed. In view of the quality data characteristics, imbalance correction coefficient and a new impurity measure FCP and FCP

Table 6 The rules generated from the decision tree

Rules	Description
Rule 1	IF (buying = vhigh AND lug_boot = med AND doors = 4) THEN Class = acc
Rule 2	IF (buying = vhigh AND lug_boot = big AND maintenance = med) THEN Class = acc
Rule 3	IF (buying = vhigh AND lug_boot = big AND maintenance = low) THEN Class = acc
Rule 4	IF (buying = high AND lug_boot = med AND doors = 4) THEN Class = acc
Rule 5	IF (buying = high AND lug_boot = big) THEN Class = acc
Rule 6	IF (buying = med AND maintenance = high AND lug_boot = small) THEN Class = acc
Rule 7	IF (buying = med AND maintenance = med AND doors = 4) THEN Class = acc
Rule 8	IF (buying = low AND maintenance = high AND lug_boot = small) THEN Class = acc
Rule 9	ELSE Class = unacc

based decision tree model were presented. Compare to other classification methods, the advantage of the proposed approach is listed in following aspects:

- Take tradeoff between precision and recall into consideration. Automatically change the weighting for different classes by the value of ICC.
- Focus on imbalance class problems. It cannot only obtain high global accuracy, but also recognize rare class instances precisely, which is obviously superior to conventional classifier.
- Reduce time on the premise of ensuring the accuracy, which remarkably raises the efficiency.

Finally, FCPDT with ICC was applied to car evaluation. On the basis of decision roles obtained by FCPDT with ICC, a potential rule was obtained. The result shown that, FCPDT with ICC was useful for evaluating a product against its functional requirements.

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Research on the Maintenance Strategy of CNC Machine Tool

Ao-fu Zhang, Li-rong Cui, and Pu Zhang

Abstract CNC machine tool is a kind of technology-integrated manufacturing equipment. With the function diversifies, especially for the high-speed and high-precision, the reliability problem which describes the sustainability of the function raised. Therefore, the paper has a very important theoretical and practical significance. This paper describes the traditional maintenance policy such as maintenance after the event, regular maintenance and state maintenance. Reasonable maintenance strategy can improve the production capacity of CNC machine tool, improve the level of system reliability, enhance the capability of self-repair and reduce the cost of using of equipment.

Keywords CNC machine tool • Corrective maintenance • Prognostic and health management • Regular maintenance

1 Introduction

For many practical systems, most of them can be repaired. In general, the system should be repaired as long as it is destructive product malfunction Caused by human action or it is not malignant failure which lost basic functions immediately (Zhang Baozhen 2008a). At the same time, Maintenance cost is worth of consideration. At present, the automotive, aerospace, nuclear power, high-tech and other products are produced by CNC machine tool. It cannot only improve production efficiency

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and machining accuracy but also improve the working conditions (Sun Bo et al. 2007). According to the date, china loses hundreds of billions of yuan is due to the product malfunction of CNC machine tool. Therefore, the fault diagnosis of mechanical component and repair security of CNC machine tool has attracted increasing attention of scholars. At home and abroad scholars do a lot of research of CNC machine tool. Maintenance policy has gone through three stages of Corrective maintenance, regular maintenance and state maintenance (Liu Jiang 2007).

Corrective maintenance activities that will maximize the use of residual life and repair product malfunction after the product go out of order (Guo Yangming et al. 2008). Regular maintenance also is regard as periodic preventive maintenance and is repaired in accordance with the predetermined maintenance cycle or the implementation of standards. State maintenance is based on the real-time state of the equipment and is renovated after the equipment show signs of deterioration (Shi Wang et al. 2009).

In the late 1990s, the project of the U.S. F-35 Joint Strike Fighter represents our strategic opportunity to put forward the views of Prognostic and Health Management which is often abbreviated to PHM. The use of PHM in the F-35 Joint Strike Fighter is a further development of the aircraft using the built-in test (BIT: build-in-test) and state monitoring. In recent years, PHM has been given widespread concern and attention of the military and Industry (Zeng Shengkui et al. 2005). PHM has been rapid development and utilization of technology in both military and civilian. PHM is an emerging engineering direction and state prediction technology that can automatically complete the fault detection, prediction, isolation and monitoring (Zhang Baozhen 2008b). In addition, we can present an objective evaluation about fault impact, fault report and the system of state management. The fact that maintenance after the event and regular maintenance is replaced by state maintenance is achieved (Scanff et al. 2007). According to statistics, Techniques used to reduce the rate of recovering fault, the cost of maintenance and security expense.

The research on product malfunction mainly focuses on the method (Chookah et al. 2011). However, there is little information regarding the mechanical parts of the machine, especially in the study of fault prediction. Thus, the research cannot meet the production requirements. For the high-tech industry, it cannot only cause huge losses to the production but also lead to some difficulties of maintenance after the NC machine tool goes wrong. The system with simple structure, lower cost and easy to repair can be used with the corrective maintenance. It cannot require any loss in down time. Therefore, the high-end CNC machine tool is suitable for regular maintenance and condition-based maintenance (Kacprzynski et al. 2002a). Mechanical components such as rails, screw and bearing should be regular maintenance. CNC machine tool numerical which contains the control system, lubrication system, servo system and electrical control system and other systems is suitable for repairing.

2 Regular Maintenance of CNC Machine Tool

The so-called regular maintenance, as shown in Fig. 1, is a preventive repair in accordance with the time interval which is regarded as regular repair. If the system is repaired between the time intervals, the repaired time will be the initial point.

Assume that the system without considering repair time will be back to normal. Thus, for the regular maintenance, the reliability function is as follows.

$$R_p(t) = [R(t)]^i R(\tau) = [R(t)]^i R(t - iT) \tag{1}$$

By time t, where $t = iT + \tau, 0 \le \tau < T,\ i(i = 1, 2, \ldots, k)$, note $R(t)$ is the reliability function, and we assume that $\lambda(t)$ is failure rate, the reliability function is

$$R(t) = \exp\left\{-\int_0^t \lambda(t)dt\right\} \tag{2}$$

When $t = iT + \tau$,

$$R(t) = \exp\left\{-\int_0^{iT+\tau} \lambda(t)dt\right\} \tag{3}$$

Then the formula (2) is substituted in formula (1),

$$R_p(t) = \exp\left\{-i\int_0^T \lambda(t)dt - \int_0^\tau \lambda(t)dt\right\}, \quad 0 \le \tau < T \tag{4}$$

We can compare the formula (3) with the formula (4). These two formulae illustrate the same form when the failure rate function is constant. It shows that regular maintenance would be improved the reliability of the system if the failure rate function is constant in random failure period. Thus the system does not require regular maintenance.

The failure rate of regular maintenance,

$$\lambda_p(t) = -\frac{1}{R_p(t)} \cdot \frac{dR_p(t)}{dt} \tag{5}$$

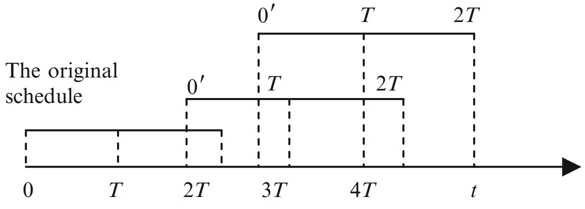

Fig. 1 The diagram of regular repair

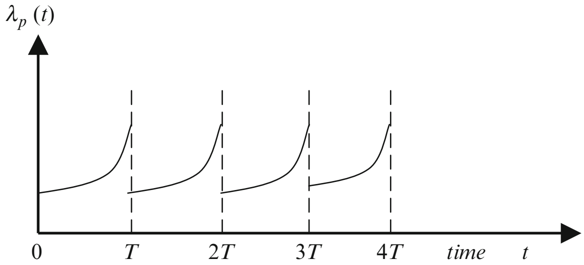

Fig. 2 The failure rate of regular maintenance

Then the formula (1) is substituted in formula (5),

$$\lambda_p(t) = -\frac{R(t)^i \cdot \frac{dR(t-iT)}{dt}}{R(t)^i \cdot R(t-iT)} = -\frac{1}{R(t-iT)} \cdot \frac{dR(t-iT)}{dt} \\ = \lambda(t-iT) \tag{6}$$

From the formula (6), the failure rate curve of regular maintenance is period curve with T. Which is shown in Fig. 2, we can conclude that the system is suitable for regular maintenance when the failure rate function is increasing function.

For any t,

$$\lambda_p \leq \lambda(T) \tag{7}$$

In order to understand wearing rules of components and system for continuous production, at first we need to determine the repair category, repair interval and repair technology. Regular maintenance contains two aspects. According to the characteristics of element, the first is supplement to fuel, lubricating oil, battery replacement, adjustment, cleaning etc. In the light of the loss characteristics of components the second is checking the failure element to repair and replacing the failing element.

3 Techniques of Fault Prediction and Health Management System in NC Machine Tool

NC machine tool can form the electromechanical equipment of machine tools, motors, computer integrated. The appearance of functional unit which contains electric spindle, spindle head, CNC turret and Automatic Tool Change device can shorten development cycle, reduce manufacturing cost and promote the emergence of a new generation of CNC machine tool. At present NC machine tool is composed of NC system, servo system, the feedback device, the machine body, etc. According to the deterioration of the system, the state maintenance can be repaired in order to eliminate hidden dangers. By analyze the sensor acquired the technology of PHM can take advantage of integrating state information. Meanwhile it can predict, monitor and manage the work state of the system with the help of various algorithms and intelligent model. It has the following main functions (Zhang Baozhen 2008a):

1. the capability of fault detection
2. the capability of fault isolation
3. the capability of fault prediction
4. the capability of tracking life
5. the capability of making decision and managing resource
6. the capability of fault selective reporting
7. the capability of residual life prediction
8. the capability of fault tolerance
9. the capability of information fusion, reasoning

Although the technology of PHM can predict time of failure and reduce maintenance support cost, the hardware facilities such as the use of advanced sensors will increase the cost. In order to reduce the risk and reduce the failure rate, the use of technology must be able to compensate for the cost and risk of introducing technology (Kacprzynski et al. 2002b). Thus, we carry out analysis of cost-effectiveness ratio. For cost effectiveness analysis of system, main steps are as follows.

1. We define two systems. The system of using PHM technology, another is not using the PHM prediction technique.
2. The components are effective measured in order to evaluate for PHM.
3. Estimate the effect of PHM in the logistics equipment cost.
4. Estimate the effect of PHM in reducing human repair.
5. Estimate the effect of PHM on training costs.
6. Estimate two cases of cost.
7. Calculate the cost-effectiveness results before and after using the technology of PHM.
8. Estimate the effect of reducing accident and the interests of decreasing serious accident.

In accordance with the above steps, we conclude that the analytical results of cost-effectiveness ratio are used to determine repair strategy of the various mechanical components of CNC machine tool.

4 A Numerical Example

When the distribution density function is an exponential function, the system cannot be regularly repaired (Ma Ning and Lu Chen 2009). In the numerical control system, the exponential distribution is available for electronic components, mechanical element, etc. Thus the system cannot be arranged in regular repair.

Reliability function is $R(t) = e^{-\lambda t}(1 + \lambda t)$. Failure rate is $\lambda(t) = -\frac{1}{R(t)} \cdot \frac{dR(t)}{dt} = \frac{\lambda^2 t}{1+\lambda t}$ when $\frac{dR(t)}{dt} = \frac{\lambda^2}{(1+\lambda t)^2} > 0$, the failure rate function is increasing function, the system is suitable for regular maintenance. And $R_p = e^{-\lambda T}(1 + \lambda T)^i \cdot e^{-\lambda \tau}(1 + \lambda \tau) = e^{-\lambda \tau}(1 + \lambda T)^i(1 + \lambda \tau)$, where $\tau = t - iT$, $i = [t/T]$. That is to say, i is equal to Non-negative integer of division t/T.

We may assume normalized time values, e.g., $\lambda T = 0.1$ $\lambda T = 0.5$ $\lambda T = 1$. The smaller the value of λT, the more the degree of reliability is. Based on extensive experimental results, when $T = 1$ day we need to check the hydraulic system of the machine tool, cutting tool, lubricating oil, spindle, slide, switch, slide surface, ventilation device etc.; when $T = 30$ days, we need to check the electrical control box, a filter, the relay and the numerical control device etc. (Hess et al. 2004).

5 Selection of CNC Machine Tool Repair Strategy

In three kinds of maintenance strategy such as maintenance after the event, regular maintenance, state maintenance, the rational selection of repair strategies should be selected to improve production efficiency, the reliability of system, and reduce the cost of equipment (Byer et al. 2001). Therefore, select repair strategies as follow.

For secondary equipments such as switches, power supply, fan and other auxiliary equipment, we adopt corrective maintenance because CNC machine tool has a minor effect on the process of the whole production. For main equipments such as rails, screw and the bearing fault, when the failure rate function is increasing function the system should be repaired by regular maintenance except for emergencies. For key equipment or the key equipment of similar function systems such as NC system, electric control system and servo system, its running state directly influence the operation of CNC machine tool (Lopez and Pecht 2009). Thus we calculate the cost-effectiveness results before and after using the technology of PHM. If results meet the producer's request, we will repair by state maintenance. If not, we will choose the regular repair.

When the equipment failure is not serious and has mutation of state, we adopt corrective management. When the equipment failure cannot be measured and has transition of state, we choose regular repair. When the equipment failure is critical and has transition of state, we select the Prognostics and health management technology (Peysson et al. 2009).

Therefore, first of all we can find out the basic situation of NC machine tool, equipment performance and the situation of maintenance in order to provide information for choosing reasonable repair strategy. Secondly, we can classify the equipment and make reliability analysis to determine the key parts of equipment and potential fault. Finally, we choose reasonable maintenance strategies to reduce repair costs and improve system reliability.

6 Conclusion

According to the characteristics of each system, the form of failure rate function as well as considering the cost-effectiveness results before and after using the technology of PHM, we analyze degradation condition of NC machine tool, thereby choosing appropriate repair method. In order to make best use of space time, ensure the quality of repair and reduce the cost of maintenance, maintenance policy should be selected reasonably.

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Study of the Application of Activity-Based Quality Cost Management Based on Linear Programming

Jing-fei Hao and Yu-jie Luo

Abstract It is important for the enterprises using activity-based costing to learn the value added activities and non-value added activities. First, the paper introduces the activity-based quality cost management, and then an activity-based quality cost management model is proposed based on linear programming. The manager can learn the value-added quality activities and non-value added quality activities by using this model; it also provides decision support for enterprises to improve their resource utilization and product quality.

Keywords Activity-based costing • Activity-based quality cost management • Cost of quality • Linear programming

1 Introduction

Since the 1950s, cost of quality (CoQ) theory has become popular. It needs a complete accounting system for accurate measurement of quality costs in order to provide accurate cost information. The traditional Cost Accounting method does not provide an accurate cost of quality data. This article will apply activity-based costing (ABC) measurements of the cost of quality. There are more advantages than traditional methods. By using the Linear Programming Method, the activity can be divided into value added activities and non-value added activities. By taking advantage of the concept of process in the ABC two-dimensional concept of cost, enterprises can detect an opportunity for improvement in the production.

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2 Methodology

2.1 Activity-Based Quality Cost Related Theory

2.1.1 CoQ and ABC

CoQ was proposed by Juran in 1951. He believed that if there were no quality problems, then all costs would be gone. After years of development, some new models have been proposed for classification and reporting of the cost of quality. Feigenbaum (1956), PAF (Prevention-Appraisal-Failure) model, calculates the cost of quality is divided into prevention costs, appraisal costs, internal failure and external failure (Feigenbaum 1956). The PAF approach of COQ is activity-oriented. Most of the costs of quality classification models are for the activities or processes (Schiffauerova and Thomson 2006).

Activity-based costing (ABC) was proposed by Cooper and Kaplan in 1988, and its purpose is to overcome the shortcomings of the traditional cost accounting, and allocation of indirect costs in order to reduce the cost allocation distortions (Cooper and Kaplan 1988). The simple principle of activity-based costing is "products consume activities and activities consume resources". Traditional cost allocation method for the allocation of manufacturing costs take on single allocation criteria; in accordance with the allocation of labor hours or machine hours each product shall bear the cost of manufacturing costs. When manufacturing costs account for a higher proportion, the disadvantage of this approach is very significant (Crosby 1979). In the ABC view, a variety of allocation criteria has been used to allocate indirect costs and accurate cost allocation to products.

A two-dimensional ABC model has been proposed, as shown in Fig. 1 (Turney 1991). The ABC model consists of two dimensions: cost allocation concept and the concept of the process. ABC's "cost allocation concept" is two-stage cost allocation of resources to cost objects. The concept of process includes three parts: the cost-motivation, activity and performance measures (Turney 1992). By the cost-motivation, the reasons of implementation of an activity can be given, based on performance measures drawn from the effects of activity implementation (Tsai 1996). A two-dimensional concept of the cost of activity performance measures may become the motivation of the cost of the next activity (Juran 1951). The information obtained in the process concept can be used as the basis for activity improvement.

2.1.2 Activity-Based Quality Cost Management Proposed

In today's competitive environment, the way enterprise seeks to gain a competitive edge through quality and cost. Improve customer satisfaction and improve the level of quality you need to balance the relationship between quality and cost. The existing Quality Costing methods cannot provide accurate cost data. And with the

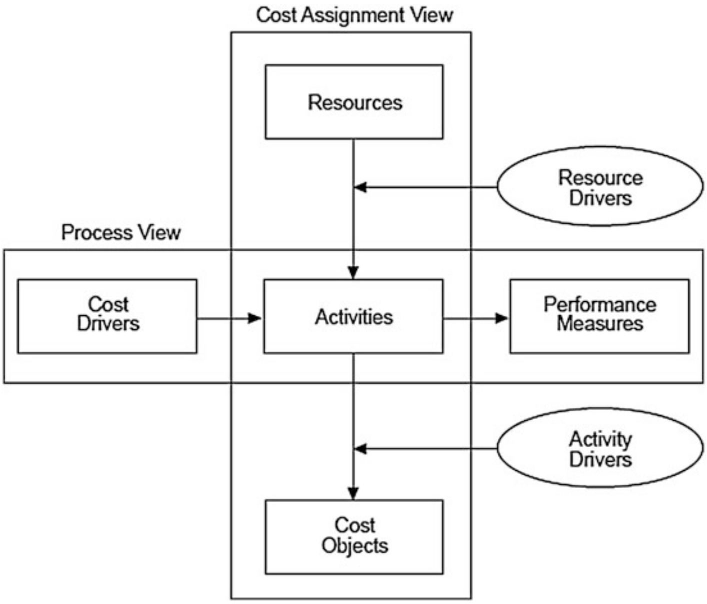

Fig. 1 Two-dimensional model of ABC

change of the quality management from the "results" to the "object", the traditional Quality Cost accounting method has been unable to meet. The traditional approach is limited to the collection of the cost of quality; quality cost and its cause cannot be linked.

The PAF quality cost model for an activity, and ABC's two-dimensional concept includes both the activity view stage and the process view stage. Combining CoQ with ABC is a good way. In the accounting system of activity of quality, Activity Cost Accounting can allocate the cost of quality management into the "activity" layer. In addition, through total quality management, activity management purposes can be achieved: in order to reduce waste in all areas and to maximize reducing the cost of resources to find the most advantageous products and investment direction (Yang Ren et al. 2001). The combination of both ABC and CoQ using a unified database and using the PAF method to measure cost of quality; Activity Cost System can provide costs, operations, process information for the cost of quality management and business process reengineering. The unity of purpose between the two is to promote the production, reduce losses, reduce throughput time, reduce costs and improve quality. CoQ-ABC model is shown in Fig. 2 (Serdar Özkan and Yasemin Zengin Karaibrahimoğlu 2012).

In the late twentieth century, Activity Quality Cost Management formed; which is a method introducing activity to cost of quality management. Letza and Gadd (1994) raised the possibility of using the ABC to measure the effectiveness of CoQ (Letza and Gadd 1994). Tsai (1998) proposed using the ABC method (Tsai 1998) in order

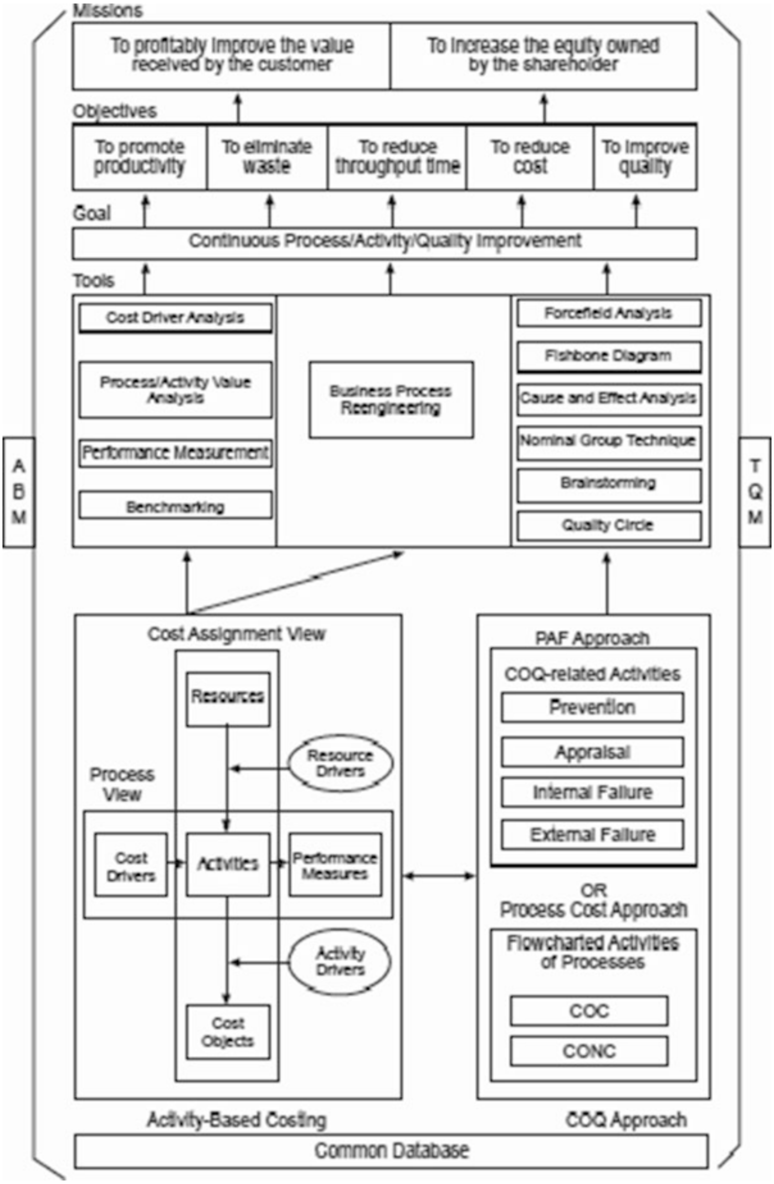

Fig. 2 Integrated COQ-ABC framework

to measure the cost of quality and obtain cost information through the collection of the activities process. Lin Wan-xiang (2001) proposed the concept of activity quality cost management. ABC provides a method to measure the cost of quality (Wan-xiang Lin 2001; Schiffauerova and Thomson 2006).

2.2 Activity Cost of Quality Management Requirements: The Division of Value Added Activities and Non-value Added Activities

Activity-Based Costing not only is a cost calculation method, but also an advanced management method. By recognizing and measuring the activity costs, dynamically tracking the activities to find the non-value added activities and by eliminating them as much as possible; value-added operations can be improved. If an activity contributes to the organizational needs or value for customers, it is the value-added; otherwise, it is non-value added (Yang 2008).

The need to find value-added activities and non-value added activities in the enterprise could reduce or even eliminate non-value added activities in order to reduce the unnecessary costs of enterprises. Then the Activity Performance Measurements can be made combined with the two-dimensional view of the ABC, in order improve the activity. We can use linear programming to find that non-value added activities improve value-added activities (Harrington 1993). Linear programming can be used for Activity Quality Cost method, mainly because of:

1. Linear Programming is the solution to the rational use of the limited human, material and financial resources to achieve the optimal allocation of resources. The activities of quality in the enterprise are scarce resource, so existence of optimal allocation issue.
2. We can use dual programming through the concept of shadow price assessment of the optimal value of activities, and then distinguish the value-added and non-value added activities. The idle activities of quality and scarce quality activities can be found in a timely manner. When value is equal to zero, then the activities of quality is idle. When the value is greater than zero the activities of quality are scarce. The larger the value the higher the degree of scarcity, and the activity is the bottleneck in the development of the enterprise (Guang-hua Tian and Lan Zhang 2004).

3 Results

3.1 Activity-Based Quality Cost Management Based on Linear Programming Model

3.1.1 The Profits of Quality – Contribution Margin of Quality

The quality of the profit is used to measure the contribution of the activity of quality for quality. Use Contribution Margin of Quality to measure the profits of quality in enterprise. Contribution Margin of Quality = Quality Income – Quality Cost. Quality revenue = K · Sales Income. The profit of quality in enterprise comes mainly from the activity of quality. The activities must be consumed as the enterprise improves the product quality. The value-added activities contribute to the profits of quality; the non-value added activities do not contribute to. So there are some relationships between the profits of quality and activities of quality. If companies want to improve the profits of quality, they are subject to the limit of the amount of activities. Interactive dual relationship is formed between the profits of quality and activities. Linear Programming can be used for activity costs of quality.

3.1.2 Divided Quality Cost Behavior

The cost of quality can also be divided into as fixed cost of quality and variable cost of quality. Contribution Margin of quality is the part of the profits from Quality Revenue minus Variable Costs of Quality, but does not include the cost of fixity.

3.1.3 The Proposed Model

First, assume enterprise had implemented ABC method to measure the cost of quality. The consumption of resources has been allocated in the quality of activity cost pools, and enterprise strictly controls the quality of activity consumption and does not exceed the standard operating conditions. Assuming that the number of products is n, the number of quality activities is m. The original programming in the form:

$$MAX\pi = C_1 \cdot X_1 + C_2 \cdot X_2 + \cdots + \mathrm{C}_j \cdot X_j + \cdots + C_n \cdot X_n$$

$$S.T \begin{cases} A_{11} \cdot X_1 + A_{12} \cdot X_2 + \cdots + A_{1j} \cdot X_j + \cdots + A_{1n} \cdot X_n \leq R_1 \\ A_{21} \cdot X_1 + A_{22} \cdot X_2 + \cdots + A_{2j} \cdot X_j + \cdots + A_{2n} \cdot X_n \leq R_2 \\ \vdots \\ A_{i1} \cdot X_1 + A_{i2} \cdot X_2 + \cdots + A_{ij} \cdot X_j + \cdots + A_{in} \cdot X_n \leq R_i \\ \vdots \\ A_{m1} \cdot X_1 + A_{m2} \cdot X_2 + \cdots + A_{mj} \cdot X_j + \cdots + A_{mn} \cdot X_n \leq R_m \\ X_1, X_2 \cdots X_{\mathrm{j}} \cdots X_n \geq 0 \end{cases}$$

The dual programming:

$$MAX\pi' = R_1 \cdot Y_1 + R_2 \cdot Y_2 + \cdots + R_i \cdot Y_i + \cdots + R_m \cdot Y_m$$

$$S.T \begin{cases} A_{11} \cdot Y_1 + A_{21} \cdot Y_2 + \cdots + A_{i1} \cdot Y_i + \cdots + A_{m1} \cdot Y_m \leq C_1 \\ A_{12} \cdot Y_1 + A_{22} \cdot Y_2 + \cdots + A_{i2} \cdot Y_i + \cdots + A_{m2} \cdot Y_m \leq C_2 \\ \vdots \\ A_{1j} \cdot Y_1 + A_{2j} \cdot Y_2 + \cdots + A_{ij} \cdot Y_i + \cdots + A_{mj} \cdot Y_m \leq C_j \\ \vdots \\ A_{1n} \cdot Y_1 + A_{2n} \cdot Y_2 + \cdots + A_{in} \cdot Y_i + \cdots A_{mn} \cdot Y_m \leq C_n \\ Y_1, Y_2 \cdots Y_{\mathrm{i}} \cdots Y_m \geq 0 \end{cases}$$

The original programming π represents the total amount of Contribution Margin of Quality, which is the part of proceeds from the Total Revenue minus Variable Costs, before the deduction of the quality activity costs and fixed costs. C_j represents Quality Marginal Contribution Margin of unit of product, which is the Marginal Revenue. X_j represents production of product j. A_{ij} represents consumed amount of jth activity to produce a unit product j. R_i represents the total amount of ith activity.

Coefficient matrix of the dual programming is the transposed matrix of the original programming. π' represents the total opportunity cost of the activity. According to the duality theorem: $\pi' = \pi$, and also because R_i represents the total amount of ith activity, Y_i represents the value of each unit activity.

3.2 SME (Small and Medium Enterprises) Case Studies

Case: Suppose a company produces two products A and B; X_1 and X_2 are their output, corresponding to each unit of product quality contribution margin amounted to 5 and 10; consumed four activities including the identification, the internal failure, the external failure and the prevention. They are inspection, rework, warranty, maintenance respectively, of these four activities (Z_1, Z_2, Z_3, Z_4), with Y_1, Y_2, Y_3, Y_4 represent the value of the unit activity, the shadow prices mentioned earlier, the total amount of these four activities are assumed to 1,151.92; 535.4; 59.24; 171.6; activities volume consumed per unit of product are shown in the following Table 1:

The original programming:

$$
\begin{aligned}
&MAX\pi = 5X_1 + 10X_2 \\
&S.T \\
&\begin{cases}
20X_1 + 36X_2 \leq 1,151.92 \\
\qquad\qquad\quad X_1 \leq 535.4 \\
\qquad\qquad\quad X_2 \leq 59.24 \\
11.5X_1 + 25.2X_2 \leq 171.6 \\
\qquad\qquad X_1, X_2 \geq 0
\end{cases}
\end{aligned}
$$

The dual programming:

$$
\begin{aligned}
&MIN\pi' = 1,151.92Y_1 + 535.4Y_2 + 59.24Y_3 + 171.6Y_4 \\
&S.T \\
&\begin{cases}
20Y_1 + Y_2 + Y_3 + 11.5Y_4 \geq 5 \\
\qquad 36Y_1 + 25.2Y_4 \geq 10 \\
\qquad Y_1, Y_2, Y_3, Y_4 \geq 0
\end{cases}
\end{aligned}
$$

Table 1 Activities volume consumed per unit of product

	Inspection (appraisal)	Rework (internal failure)	Warranty repair (external failure)	Maintenance (prevention)
	Z_1	Z_2	Z_3	Z_4
P_1	20	1	1	11.5
P_2	36	0	0	25.2

Table 2 Optimal solution and sensitivity analysis optimal combination

Optimal combination		
Product name	The final value	Decreasing gradient
P_1	14.9217	0
P_2	0	0
Constraints		
Activity name	The final value	Lagrange multiplier
Z_1	298	0
Z_2	14.9217	0
Z_3	0	0
Z_4	171.35	0.4348

3.3 *Analysis of Results*

Using MATLAB to solve and the sensitivity analysis are shown in Table 2,

Table 2, the dual optimal solution: $(\pi', Y_1, Y_2, Y_3, Y_4) = (74.61, 0, 0, 0, 0.4348)$. The shadow price (Y_1, Y_2, Y_3, Y_4) economic sense: each additional units of the activity enterprise unit revenue (0, 0, 0, 0.4348), because $Y_4 > 0$, so the prevention activity is value added operations, $Y_1, Y_2, Y_3 = 0$, so the identification activities, internal failure activities and external failure activities are non-value added activities.

The optimal solution of the original programming: $(\pi, X1, X2) = (74.61, 14.92, 0)$. Therefore, the optimal production of 14 P_1, zero P_2 products. X_1, X_2 into the original plan was found that there is an unused activity. The corresponding quality activities should be reduced or take full advantage of the activity of quality.

4 Discussion

On the basis of the two-dimensional concept of Activity-Based Costing and the use of Linear Programming, an analysis of the operating cost of quality is as follows: Come to the activities of identification, external failure and the internal failure are non-value added activities, only activities of preventive is value-added operations. This is consistent with the actual situation. But for quality activities in the non-value added should not be simply eliminated, divided into the necessary activity and non-essential activities. The processing of non-value added activities need further discussion.

The linear programming is static, future research should be the development of the dynamic direction.

5 Conclusion

In this paper, a brief description was provided for the Activity-Based Costing and the Cost of Quality, along with discussing the feasibility of the combination of the two. In addition, the advantages of this method are described. Finally, by Linear Programming, dual theory of the activities can be divided into value-added activities and non-value-added activities. Enterprises should try to eliminate non-value added activities, and improve value-added activities, which can effectively reduce costs, improve quality.

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Application of Artificial Neural Network for the Optimal Welding Parameters Design of Aerospace Aluminum Alloy Thick Plate

Jhy-Ping Jhang

Abstract This research proposes an economic and effective experimental design method of multiple characteristics to deal with the parameter design problem with many continuous parameters and levels. It uses TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) and Artificial Neural Network (ANN) to train the optimal function framework of parameter design for the thick plate weldment of aerospace aluminum alloy. To improve previous experimental methods for multiple characteristics, this research method employs ANN and all combinations to search the optimal parameter such that the potential parameter can be evaluated more completely and objectively. Additionally, the model can learn the relationship between the welding parameters and the quality responses of different materials to facilitate the future applications in the decision-making of parameter settings for automatic welding equipment. The research results can be presented to the industries as a reference, and improve the product quality and welding efficiency to relevant welding industries.

Keywords ANN • Aerospace aluminum alloy • TIG • TOPSIS • Taguchi method

1 Introduction

The welding of different metal materials has superior mechanical characteristics, but the feasible setting for the welding parameters of the TIG has many difficulties due to some hard and crisp inter-metallic compounds created within the weld line.

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Normally, the setting for welding parameters does not have a formula to follow; it usually depends on experts' past knowledge and experiences. Once exceeding the rule of thumb, it becomes impossible to set up feasibly the optimal parameters, and the past researches focus on thin plate. This research proposes an economic and effective experimental design method of multiple characteristics to deal with the parameter design problem with many continuous parameters and levels for the aerospace aluminum alloy thick plate.

It is difficult to solve the optimization problem of multiple parameters by analytical method. The search algorithm is easy to fall into local optimal but not global optimal.

Jhang and Chan (2001) applied Taguchi Method with orthogonal table of L18 and quality characteristic of smaller-the-better to improve the process yield rate for air cleaners in Toyota Corona.

Tong and Wang (2000) proposes the algorithm of Grey relational analysis and TOPSIS for multiple quality characteristics.

Tong and Su (1997a, b) proposes multi-response robust design by principal component analysis and by Fuzzy multiple attribute decision making.

Su et al. (2000) use Soft Computing to overcome the limitations of practical applications for Taguchi method. The methods used the ANN (Artificial Neural Network), GA (Simulated Anneal) and SA (Genetic Algorithm), to compare and find the global optimal solution for multiple quality characteristics.

Juang and Tarng (2002) find that the factors of welding current and welding torch drift speed are important factors for the quality of welding.

Chan et al. (2006) propose a new method for the propagation system evaluation in wireless network by neural networks and genetic algorithm.

Chang (2006) The proposed approach employs a BPN to construct the response model of the dynamic multi-response system by training the experimental data. The response model is then used to predict all possible multi-responses of the system by presenting full parameter combinations.

Chi and Hsu (2001) propose a Fuzzy Taguchi experimental method for problems with multi-attribute quality characteristics and its application on plasma arc welding.

Lin and Lin (2002) propose the use of the orthogonal array with grey relational analysis to optimize the electrical discharge machining process with multiple performance characteristics.

In order to be efficient for solving optimal parameters problems, our research uses TOPSIS (Technique for Order Preference by Similarity to Ideal Solution) and ANN to find the global optimal function framework of parameter design for the thick plate weldment of aerospace aluminum alloy.

2 Methodologies

2.1 Structure

This research collects the data of welding Taguchi experiments. There are non-destructive quality characteristics such as weld width, thickness, the ratio of melting into the deep, and the destructive quality characteristics such as tensility, shock. We compute S/N ratios, response graph, response table, the optimal combination of factor levels, ANOVA, contribution rate for multiple quality characteristics, which are compiled into a Cross Table to find the integrated optimal combinations. We use TOPSIS method to integrate all S/N ratios of multiple quality characteristics into Ci. The factors level and Ci values are training by ANN to find the optimal frame which associates all combinations to find global optimal solution. Finally, the global optimal is obtained by the confirmation experiment of different optimal solutions with respect to different methods.

2.2 TOPSIS

Hwang and Yoon (1981) have developed multiple criteria evaluation method called TOPSIS, taking into account the basic concept that are the distances from each program to the ideal solution and negative ideal solution, so the selected program is near ideal solution and far from the negative ideal solution. The analysis steps are as follows:

Step 1. Create the performance matrix with respect to the evaluation criterion.
Step 2. The performance values are standardized. As follows:

$$r_{ij} = \frac{x_{ij}}{\sqrt{\sum_{i=1}^{m} x_{ij}^2}} \tag{1}$$

where x_{ij} is i program under j evaluation criteria.
Step 3. The performance matrix is multiplied by the weight of each criterion.
Step 4. To calculate the distance of ideal solution (S_i^+) and the distance of the negative ideal solution (S_i^-).

$$S_i^+ = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^+\right)^2} \tag{2}$$

$$S_i^- = \sqrt{\sum_{j=1}^{n} \left(v_{ij} - v_j^-\right)^2} \tag{3}$$

Where, $v_j^+ = \max_i [v_{ij}], v_j^- = \min_i [v_{ij}]$.

Step 5. Arrange the priorities of the programs.

$$C_i = \frac{S_i^-}{S_i^+ + S_i^-} \tag{4}$$

where C_i is between 0 and 1, the priority of the i-th program is higher when C_i is closer to 1.

3 Experimental Planning

3.1 Experimental Allocation

In this study, we use the welding material is the aerospace aluminum alloy (7,075) thick plate (8 mm), size is 80 mm × 60 mm × 8 mm, the welding diagram is showed in Fig. 1, 5 sets of control factors are considered; each control factor has 3 levels. Please refer to Table 1 for the experimental factor and its level. The noise factor is 3 different welding operators. This research adopts the orthogonal table of L_{27}.

There are five quality characteristics as follows.

1. Welding thickness and width
   In the welding track of aluminum alloy plates, from left to right we measure the welding thickness and width for the five points of 20, 25, 30, 35, 40 mm.

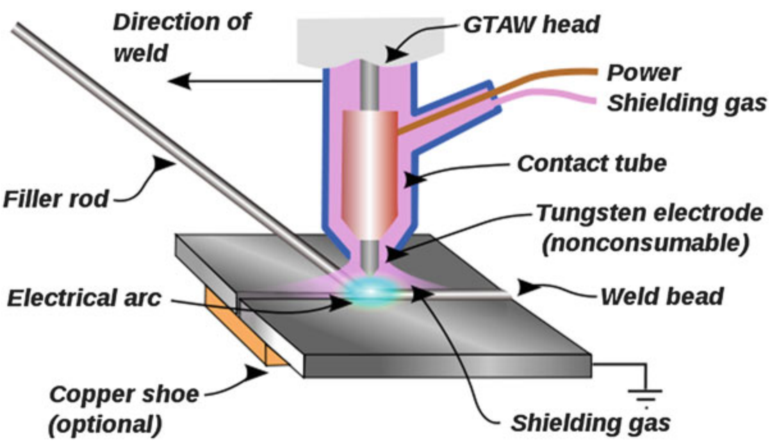

Fig. 1 The welding graph

Table 1 Experimental factors and levels

Control factor	I	II	III	Unit
A. Electric current	170	180	190	A
B. Moving speed	15	16	17	cm/min
C. Welding gap	1.5	1.7	1.9	mm
D. Striking Tungsten length	5	8	11	mm
E. Gas flow rate	11.5	13.5	15	l/min
Noise factor	**3 different welding operators A, B, C**			

2. The ratio of melting into the deep
   The ratio is welding length in the front side over the reverse side.
3. Tensile strength and shock value
   Tensile test specimens conform CNS 2112 G2014, and in accordance with the specimen 13B. Shock test is the specimen compliance CNS 3033 G2022, and in accordance with V-concave regulations.

   The formula of energy shock is

$$\mathrm{E} = \mathrm{Wh}_1 - \mathrm{Wh}_2 = \mathrm{WR}\,(\mathrm{COS}\,\beta - \mathrm{COS}\,\alpha) \tag{5}$$

   Where,

   α: initial angle, 143°
   β: shocking angle
   W: weight, 26.63 kgf
   R: radius, 0.635 m

3.2 *Analysis of Individual Quality Characteristic*

In this study, the quality characteristics of welding thickness, tensile strength and shock value are all considered as larger-the-better, but the quality characteristics of welding width and the ratio of melting into the deep are considered as nominal-the-best.

$$\text{nominal-the-best}\ \ S/N = 10 \times \log\left[\frac{S_m - V_e}{n \times V_e}\right] \tag{6}$$

$$\text{larger-the-better}\ \ S/N = -10 \times \log\left[\frac{1}{n}\sum_{i=1}^{n}\frac{1}{y_i^2}\right] \tag{7}$$

where, $S_m = \frac{\left(\sum y_i\right)^2}{n}$,

$$V_e = \frac{1}{n-1}\left(\sum y_i^2 - S_m\right).$$

3.3 Analysis of Multiple Quality Characteristics

We compute the S/N ratios, the optimal combination of factor levels, ANOVA, contribution rate of multiple quality characteristics respectively, which are compiled into a Cross Table to find the optimal combinations.

We also use S/N ratios of multiple quality characteristics to transform into the Ci value of TOPSIS. The value of the five levels of control factors as input, the Ci value of TOPSIS as output, use BNN to build models. In this study, we select the marginal value (the maximum and minimum) and the median value of 27 groups of samples as the test samples, and the remaining samples for training, the criteria of decision-making is according to the MSE values of ANN, the MSE of training samples and test samples are the more smaller the more better. The optimal frame which associates all combinations finds global optimal solution.

4 Results Analysis

4.1 The Optimal Combinations of Cross Table

We compute the S/N ratios, the combination of factor levels, ANOVA, contribution rate of multiple quality characteristics, which are compiled into a Cross Table to find the optimal combinations, as shown in Table 2.

4.2 The Optimal Combinations of TOPSIS

We use TOPSIS method to integrate all S/N ratios of multiple quality characteristics into Ci and to find the optimal combination as shown in Table 3.

4.3 Confirmation Experiment

The 95 % Confidence interval of Ci for the confirmation experiment is [0.44, 1.07].

4.4 Results and Discussions

From Table 4, the Ci of ANN and all combinations is larger than Ci of Cross table, and it falls into the 95 % confidence interval of Ci for the confirmation experiment.

Table 2 Cross table

Factor	A	B	C	D	E
Welding thickness (10 %)					
Optimal combination	A3	B1	C1	D1	E3
Significant of S/N	*			*	*
Contribution rate (%)	18	2	4	43	12
Welding width (10 %)					
Optimal combination	A2	B2	C3	D1	E2
S/N significant	*	*	*		*
Contribution rate (%)	0	3	5	26	0
The ratio of Melting into the deep (25 %)					
Optimal combination	A2	B2	C1	D3	E2
S/N significant		*		*	
Contribution rate (%)	15	2	3	37	10
Shock value (15 %)					
Optimal combination	A3	B1	C3	D2	E3
S/N significant		*	*	*	*
Contribution rate (%)	4	4	4	4	4
Tensile strength (40 %)					
Optimal combination	A2	B2	C3	D2	E3
S/N significant			*	*	*
Contribution rate (%)	6	0	23	15	6
Optimal parameters levels	A2	B2	C3	D2	E3

*The difference of S/N ratio is larger than average

Table 3 Response table of Ci

	Factor	A	B	C	D	E	Average
Ci (TOPSIS)	Level1	0.45	0.47	0.46	0.34	0.45	0.43
	Level2	0.56	0.55	0.43	0.57	0.53	0.53
	Level3	0.49	0.48	0.61	0.58	0.54	0.54
	Comparison	0.10	0.08	0.18	0.24	0.14	0.14
	Best level	A2	B2	C3	D3	E2	
	Rank	3	4	2	1	5	
	Significant			*	*		

*The difference of S/N ratio is larger than average

Table 4 The comparison Ci of confirmation experiment

	Cross table	TOPSIS	
Optimal combinations	A2B2C3D2E3	A2B2C3D3E2	ANN and all combinations
Ci value	0.77	0.90	0.93

So the optimal combination ANN and all combinations is the total optimal welding parameters design of aerospace Aluminum alloy thick plate.

The significant factors are welding gap and striking Tungsten length.

Table 5 The standard of operation for welding parameters design of aerospace aluminum alloy thick plate

Control factor	Level
A. Electric current	200
B. Moving speed	8
C. Welding gap	1.5
D. Striking Tungsten length	5
E. Gas flow rate	11.5

5 Conclusion

The conclusions are summarized in the following:

1. The ANN and all combinations method used in this case is better than others. So the optimal combination of ANN and all combinations is the total optimal welding parameters design of aerospace Aluminum alloy thick plate. The SOP for welding parameters design of aerospace Aluminum alloy thick plate is showed in Table 5.
2. The significant factors are welding gap and striking Tungsten length in this case.
3. In the future, we can consider to use the ANN, GA and SA to find the optimal solution for multiple quality characteristics. We can also consider other welding techniques, such as CO_2 welding, GMAW (Gas Tungsten Arc Welding) and LAFSW.

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The Theoretical Framework of Modern Equipment Operation and Maintenance Management in Grid Enterprise

Jia-xu Cheng

Abstract The equipment operation and maintenance in grid enterprise is an important part of equipment management, especially in the current stage of rapid development of ultra-high voltage grid and smart grid. The equipment operation and maintenance management issues off the grid safe operation and reliability of power supply protection. Meanwhile, with the constantly enhance in Chinese electric power reform and power supervision, the grid enterprises need to further optimize equipment maintenance management models and processes, reduce equipment management costs, improve maintenance level. In this paper, development of production management is sorted out, the features of grid equipment operation and maintenance management are analyzes. The grid equipment operation maintenance management theoretical framework is built. The theoretical framework provides useful lessons for power enterprises the implementation of scientific and effective equipment operation and maintenance management.

Keywords Equipment management • Operation and maintenance management • Theoretical framework

1 Production Management Theory Development Course

Since the beginning of the twentieth century after the birth of Taylor's Principles of Scientific Management, Ford has invented the assembly line in 1913, the prelude of the modern large-scale industrial production is opened; on 1970s, computer technology has been widely used in the production management, material requirements planning (MRP) and manufacturing resource planning (MRPII) came into being. In the 1980s, just-in-time production (JIT) came into being, which

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uphold the most production with the least-stock, and total quality control (TQC) into one, to achieve zero defect production. On the same period, another important production management results is total quality management (TQM), it makes a more comprehensive and systematic perspective on the quality of the products and services. On these bases, the Six Sigma quality of management in turn greatly has reduced the cost, centralized and been efficient to improve the quality of business process management. With the continuous improvement of the competitiveness of enterprises, the lean production gradually has been promoted, lean production more emphasis on flexibility and quality (Xiu-pang Wang et al. 2008).

At present, the more popular production management theories include of management constraints theory, just-in-time manner, lean production methods, industrial engineering and Six Sigma.

1. The core idea of the constraints theory is to identify the "bottleneck" or "constraints" in the business operations, maximize the use of limited resources to enable enterprises to significantly improve operations and profitability in a short period of time.
2. JIT represents an intensification of management thinking. It is possible by doing everything to reduce all waste in the production process, decrease consumption and conserve resources to improve efficiency and effectiveness.
3. The core idea of lean production, on the one hand, stresses that "eliminate waste, streamline the organization", on the other hand, stresses the "continuous improvement", gives full play to human potential, strives for excellence, to pursuit efficiency and effectiveness of the management.
4. The core of industrial engineering is to reduce operation and maintenance costs, improve quality and efficiency. The purpose of using engineering and management science is realized.
5. The Six Sigma is a strictly centralized and efficient implementation of the principles and techniques to improve the quality of business process management. Its' major breakthrough in the pursuit of "zero defect" perfect business is driven by the cost of a significant reduction in safety equipment and a significant increase in financial effectiveness, and ultimately significantly to improve the competitiveness of enterprises.

2 The Features of Grid Business Equipment Operation and Maintenance Management

2.1 The Grid Operation and Maintenance Is Technology-Intensive Large and Complex Management System

The power system is the world's largest and most widely used man-made systems. Grid operation and maintenance work involves in different voltage levels of the network and a number of distribution equipment, as well as operation and maintenance, repair, condition monitoring, repair, technical innovation, maintenance management business, also related to grid security, equipment security, personal security, asset effectiveness and personnel maintenance efficiency. It needs to lean device manager (Qing-jun Shuai 2010).

2.2 The High Degree of Homogeneity Between the Transmission and Distribution Network in the Equipment Maintenance Management

Although the grid enterprises transmission and distribution power business is large-scale, wide geographical coverage, with some regional differences, overall equipment operation and seizure operations are almost entirely homogeneous. This is mainly reflected in the transmission and distribution operation can share relevant technology, equipment and professional talent. This will enable us to bring the economies of scale of the network equipment operation and maintenance, reducing the company's overall operating costs, but also conducive to the full copy of the advanced management mode (Junfang Li et al. 2013; Ji Ye and Hai-bo Tang 2013).

2.3 The High Degree of Coordination and Job Dispersion Characteristics in Equipment Operation and Maintenance

Power is different from other products, with cannot be stored, supply and demand balance in real time, and to comply with certain laws of physics and other special technical characteristics. These characteristics cause the high complexity of the power system operation. For a long time, China's power grid system is divided into scheduling operation and equipment run, through the close collaboration of the grid scheduling, equipment management, equipment operating status is controllability in control, to ensure the security and stability of economic operation. Equipment operation and maintenance is in the grid operation frontline forefront, the key link of the network equipment business. It bears the major responsibility for ensuring network security, improving the efficiency and effectiveness of the work, with over a broad area, decentralized operations, complex process, and high timeliness (Wenying Liu et al. 2013a, b; Ming Zeng et al. 2013).

There are large influences in the cost of equipment operation and maintenance business efficiency by the core business segments, such as grid planning, infrastructure and so on. Grid planning, design, construction, operation, maintenance, technological innovation and other sectors, as a complete system, affect network security and operational efficiency of the asset. Forward segments, such as planning, design, construction and other aspects directly impact on the level of quality in the equipment, and determine the equipment put into operation after maintenance workload and operation and maintenance costs. At the same time, category of device models, technical level requirements for operation and maintenance personnel training, equipment investment will have a direct impact. Grid planning, construction, control and operation of maintenance are a highly coordinated, complementary and inseparable business system (Tian Mao et al. 2013).

3 The Theoretical Framework of Grid Equipment Operation and Maintenance

In accordance with the modern enterprise production management theory, combined with the characteristics of the grid business equipment maintenance, the grid business equipment operation and maintenance theory involves in lean management, total quality management, organizational management, performance management, asset life cycle management, process management, standardized management, equipment management and so on. To Sum up, the theoretical framework of grid equipment operation and maintenance is refined and shown in Fig. 1.

The guide grid business equipment operation and inspection of lean management should be a comprehensive theory, by the theory of the formation of an organic whole. Equipment operation and maintenance process in power grid enterprises is around the core goal of lean operation and maintenance management, total quality management as the basis for organizational change, standardized management and process reengineering as a means to the asset life cycle management and performance management pillar, as the starting point to the device state management, the theoretical framework of equipment operation and maintenance management together constitute the modern power grid enterprises.

3.1 Lean Management Is the Core Objectives of the Equipment Operation and Maintenance in the Grid Enterprises

It is to aim to minimum the cost of the equipment in the power grid enterprises, to eliminate all waste behavior in the device manager link in the operation and maintenance, overhaul and repair, and technical innovation, to save human, financial, material and other maintenance costs and reduce waste of time. It meets

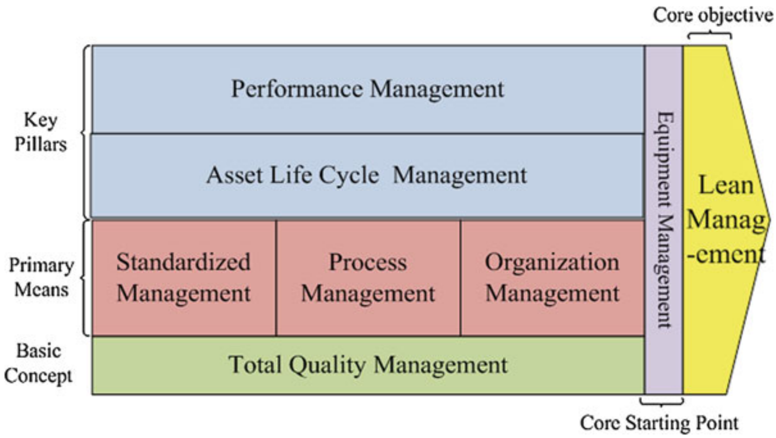

Fig. 1 The theoretical framework of modern grid equipment operation and maintenance

the management requirements of network equipment maintenance with minimum capital investment, thereby increases the economic benefits of the network equipment maintenance.

3.2 *Total Quality Management Is the Basis of the Grid Equipment Operation and Maintenance*

All sectors and staff in power grid enterprises should be enhance the quality of grid operation as the core goal, and integrate monitoring technology, maintenance technology, management skills, information technology, establish a set of scientific and strict and efficient quality assurance system covering plan, do, check and act, control network equipment operation and maintenance process factors which affect the quality of the running, and constantly improve the quality of maintenance.

3.3 *Organization Management Is the Key to the Innovation of the Grid Enterprises Equipment Operation and Maintenance Relationship*

Organization and management in accordance with the characteristics of the enterprise management uses scientific management methods to adjust the organizational structure and management level, to regulate the duties of the organization. So that, the relations of production continue to adapt to the needs of the productive forces development.

3.4 Process Management Is the Requirement of the Grid Enterprises Operation and Maintenance Lean Specification

Process management is the power grid enterprises inside reform. It changes drawbacks such as the grid enterprise functions overlapping, intermediate level, non closed-loop process, to shorten the process cycle and save costs. Through specification grid operation and maintenance repair business by process management, operation and maintenance core business processes are combed, process optimization and process reengineering are carried out. The operation and maintenance various aspects of the business are coordinated. The business process management is always throughout the lean operation and maintenance, to save operation and maintenance repair costs and improve the efficiency of operation and maintenance management.

3.5 Standardized Management Is the Primary Means and Approaches of Power Grid Enterprises Equipment Lean Management

Through standardized management operational guidelines for the power grid enterprises operation and maintenance are formed. These guidelines standardize the activities and all aspects of the power grid enterprises, to ensure the stability of the power grid operation and maintenance quality, and improve grid operation safety and reliability of power supply.

3.6 Life Cycle Asset Management Is an Important Pillar of Power Grid Enterprises Equipment Operation and Maintenance

Asset life cycle management based on the concept of the least life cycle cost controls grid operation equipment costs incurred by the whole process. It unified manages the physical shape and value form, and scientifically plan and reasonable extended equipment life, to save operation and maintenance cost, and support grid enterprises operation and maintenance lean goals.

3.7 Performance Management Is the Incentive Mechanism of Grid Enterprises Operation and Maintenance Lean Management

Performance management by target decomposition implements the overall objectives of grid equipment operation and maintenance to unit goals of the relevant organizations and individual. The macro and micro level in the direction is unified. Through reward and punishment mechanism, the benefits of equipment operation and maintenance are linked to interests of employees, and to promote lean of operation and maintenance truly become the ultimate goal of each employee.

3.8 Equipment Management Is an Important Starting Point of the Power Grid Enterprises Equipment Operation and Maintenance Management

The grid enterprise equipment management pays attention to the closed-loop management aspects, such as equipment production, operation, condition monitoring, maintenance, technical maintenance, scrap and so on. Through the optimization of equipment operating status, it is to achieve the sustainability of the power grid safe equipment operation. Through the device status evaluation to effectively reduce the rate of equipment maintenance, the equipment management uses standardized and scientific lean management methods, focuses on efforts to strengthen the suffering of online monitoring and maintenance scheduling on equipment defects and hazards, to timely eliminate the causes of various network equipment accidents, to improve the relevance and effectiveness of equipment maintenance, and extend equipment available time and equipment replacement cycle.

According to the theoretical framework of grid equipment operation and maintenance management, it combines with grid operation and maintenance business practice throughout the operation and maintenance lean management philosophy in the modern operation and maintenance management system construction as a whole. The total quality management, asset life cycle management, standardization management, and process management, are integrated in equipment quality source control, equipment quality supervision before putting into operation, the quality of equipment operation and maintenance, the quality of equipment maintenance work, the quality control of operation and maintenance business outsourcing, the technical supervision and management, as well as technical innovation maintenance. With performance management, the operation and maintenance management objectives are embraved and facilitated the implementation.

4 Revelation of the Power Grid Enterprises

The equipment operation and maintenance is an important part of the electric power enterprises production management. And it is relationship to the power grid the safe operation of important link, but also there are a lot of new trends in the power grid enterprises equipment operation and maintenance. China's power grid enterprises have to cause a high degree of great importance to these new trends. Specifically, the experience of enlightenment on the grid enterprises includes the following aspects.

4.1 The Core Goal of the Modern Power Grid Enterprises Equipment Operation and Maintenance Is to Lean

Maintenance of power grid enterprises should be managed around the lean core objectives, total quality management as a basis for the protection of organizational change and process reengineering, asset life cycle management and performance management as the pillar, standardized management as the means, the device state management as a key starting point, to establish a modern enterprise management system of maintenance. Grid equipment operation and maintenance management is complex. The business not only involves a broader, more fields to carry out the management of specific starting point may be emphasized and different. Among them, to achieve lean is the fundamental purpose of the power grid enterprises equipment of each business. Each business as a major component of the equipment operation and maintenance management system shall constitute the organic whole (Min Tao and Feng Yao 2013).

4.2 The Power Grid Enterprises Equipment Operation and Maintenance for Management Development Presents the Trend of Flattening, Standardization, and Specialization Management

Advanced power grid enterprises maintenance management practice shows that the majority of advanced power grid enterprises has established division system as the core flattening equipment operation and maintenance management organizational structure, have implemented the comprehensive coverage of continuous improvement standardization of equipment maintenance management. In operation and maintenance practice, these enterprises uphold the reliability-centered state maintenance strategy, and gradually develop the implementation of the social resources assigned outsourcing to further promote the professional maintenance of the equipment. They have used centralized monitoring, operation and maintenance integration mode, and continued to implement closed-loop asset management system based on the life and status, implemented performance evaluation management to adapt to the development of modern power grid (Bing Hu et al. 2013).

4.3 The Power Grid Enterprises Comprehensively Promote the Equipment Asset Life Cycle Management

Equipment asset life cycle management needs to penetrate the various stages of enterprise asset management, all aspects, through the process of data collection and statistical analysis, the closed-loop management system of the device asset management has formed. Power grid enterprises should be adopt in accordance with scientific and reasonable information and data which analysis the various factors that that affect the device manager, and coordinated the relationship between of the key link, thereby to meet the from the project establishment, planning, construction, to repair to the assets has to be retired at the end of their life the whole process of equipment optimal management costs and benefits maximized.

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Research on Risk Quantification of Comprehensive Unit Price Based on Fuzzy Theory

An-na Dai and Ling Yan

Abstract The cost of risk of comprehensive unit price of bidding control price is usually determined by the comprehensive risk factors of competent authorities without considering the bidders' ability to undertake the risks. Comparing three kinds of Risk Quantification models, this paper points out that the comprehensive risk parameter model based on the fuzzy theory is the best way to evaluate the cost of risks. Meanwhile, on the basis of considering the characteristics of a hypothetical illustrative example, this paper provides optimized model by combining risks with the rate of profit, which will improve the veracity of bidding control price.

Keywords Bidding control price • Comprehensive unit price • Fuzzy theory • Risk

1 Introduction

Bidding control price occurs for the first time in the "Code of valuation with bill quantity of construction works" (GB50500-2008) (hereinafter referred to as "08 bill quantity code"), which is formulated in accordance with normal construction conditions, and reflects the social average advanced level. Its aim is to avoid the bidders driving up the price and the colluding behavior in bidding. The comprehensive unit price of the bidding control price points to the cost of performing a required units of measurement list item, which includes the cost of labor, material, constructor's mechanical plant, enterprise administration expense, profit and risk (GB50500-2008 2008).

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In the process of preparing the tender documents, the calculation of the comprehensive unit price is the core of the bidding strategies, which has the impact on the cost, quality, and schedule of the project implementation. The cost of labor, material, constructor's mechanical plant, enterprise administration expense and profit of the comprehensive unit price can be calculated by the quota and the market price. The "within scope of the risk" is usually determined by the rate of administrative fee and the profit in the quota or the risk parameter released by the construction department. But in this way, the cost of the risk just reflects the market average but not the characteristics of the specific project (Jiang Hong et al. 2006; Jiang Li et al. 2010), which will bring down the accuracy of the bidding control price and influence the project implementation. At the same time, determination of the cost of the risk in the comprehensive unit price is the starting point of the contract management, which has an important impact on the change, claim and settlement management.

In order to improve the accuracy of the cost of risk in the comprehensive unit price of bidding control price, clear that the tenderee's requirement on the bidders' degree of risk and lay the foundation of contract management, it needs to study the risk factors of the comprehensive unit price using quantitative method.

2 Study Review on the Risk in the Comprehensive Unit Price

2.1 The Scope of the Risk in the Comprehensive Unit Price

The comprehensive unit price consists of the cost of labor, material, constructor's mechanical plant, enterprise administration expense, profit and within scope of the risk, and we should consider the scope of the risk from these aspects. In accordance with the 08 bill quantity code, the risk factors and the risk range in the comprehensive unit price is the one undertaken by the bidder. According to the characteristics of the engineering construction in China, bidder should completely undertake the technology and management risk, such as the enterprise administration expense and profit risk; and share the market risk (such as material price risk and mechanical price risk) with the tenderee. The risk of the change of the policy is completely undertaken by the tenderee (Lam 2007; Ke Shuling and Huang Ying 2011; Lei Shyin 2008). The classification see Table 1.

Because of the risk factors and the risk range in the comprehensive unit price undertaken by the bidder, the study on the risk in the comprehensive unit price should pay attention to the risk of material price, mechanical price, enterprise administration expense and profit.

2.2 Quantitative Study on the Risk Expense

The expense of the risk is usually calculated by the risk parameter release by the construction department. Considering the specialty, the uniform risk parameter can't

Table 1 The classification of the risk in the comprehensive unit price

Evaluation index	Risk category: Risk caused by the prices fluctuation	Bidders' management risk	Risk of the change of policy
Content of risk	The price of the material and mechanical plant	Enterprise administration expense and profit	Engineering taxes, change of the price of labor
Influence factors	Prices fluctuation, the loss rate of the material, construction scheme etc.	Management level, engineering experience, competitors' capability	–
Risk carrier	Bidding documents should specify the scope and the range of the risk	Bidder	Tenderee

reflect the characteristic of the engineering project. In order to improve the accuracy and rationality of the comprehensive unit price, we should quantize the expense of the risk in accordance with the characteristics of the project.

There exist three kinds of methods quantizing the expense of the risk: Itemizing Risk Calculation Model (Li Xiao and Zhou Guohua 2009), Comprehensive Risk Parameter Model (Li Yanling 2009; Liu Caixia 2008) and Risk-Profit Rate Model (Liu Caixia 2008; Liu Fei and Sun Chen 2010; Liu Jing 2006; Zhou Yanru et al. 2012).

2.2.1 Itemizing Risk Calculation Model

When it comes to analyze the comprehensive unit price, calculate the expense of the risk of material price, mechanical price, enterprise administration expense and profit detailedly. And then calculate the comprehensive unit price with the formula:

$$P = (F_1K_1 + F_2K_2 + F_3K_3) \times (1 + f) \tag{1}$$

In the formula:

P—the comprehensive unit price;

F_1,F_2,F_3—the cost of material, constructor's mechanical plant and enterprise administration expense without considering the risk factors;

K_1,K_2,K_3—the risk parameter of the cost of material, constructor's mechanical plant and enterprise administration expense;

f—the rate of the profit.

Using the price index and the price rate of the last few months, each part of risk parameter can be predicted by the mathematical model, such as Curve Fitting Model, Moving Average Model, Long-term Trend Model etc. Because of the diversity of the material and the mechanical plant, it's complex to analyze each part of risk. If we deal with the price information with the computer technique, it will be more convenient.

Table 2 Comparison of risk quantize model

	Introduction	Theory involved	Discussion
Itemizing risk calculation model	Itemizing calculating each parts' expense of risk	Curve fitting model, long-term trend model	It's complex to analyze every part of risk Because of the diversity of material
Comprehensive risk parameter model	Summarizing every part of comprehensive unit price to calculate the comprehensive risk parameter	AHP and fuzzy membership analysis	Considering the risk in a comprehensive way, it's more convenient and practical
Risk-profit rate model	The quantitative analysis reflects on the profit rate	AHP, fuzzy evaluating model and linear interpolation	Combined with the profit rate which can improve the accuracy. The application of mathematical model is the restriction of the model

2.2.2 Comprehensive Risk Parameter Model

This model combines the Analytic Hierarchy Process (AHP) with the fuzzy membership analysis, calculating the risk parameter and the comprehensive unit price. There are three steps: (1) Determine risk factors' weight with AHP; (2) Evaluate the fuzzy membership of each part of risk according to the risk level and set up the risk fuzzy evaluating matrix; (3) Combine the risk factors' weight with the risk fuzzy evaluating matrix, assign the evaluation set and determine the comprehensive risk parameter, which is used to calculate the expense of the risk.

2.2.3 Risk-Profit Rate Model

Risk-Profit Rate Model is similar to the Comprehensive Risk Parameter Model. Both of them require determining risk factors' weight with AHP, evaluating the risk according to the risk level and setting up the risk fuzzy evaluating matrix.

In order to improve the accuracy of the expense of risk, Risk-Profit Rate Model pays more attention to the bidders' profit rate. According to the characteristic of the project, the model set up the profit rate matrix with the bidders' profit level D = (d1, d2, d3, d4), in which d1, d4 is the maximum and minimum profit rate and d2, d3 are determined by linear interpolation. And last calculate the risk profit rate with the risk fuzzy evaluating matrix and profit rate matrix. This model takes full advantage of fuzzy membership analysis and the calculation software. It's an effective method to analyze the expense of risk with the profit rate (Wu Yinping and Liu Yuyang 2009).

The three models above-mentioned have their own specialty, see Table 2.

In the three models above-mentioned, Itemizing Risk Calculation Model predicts the risk parameter through the price index and price rate of the last few months, which is very complex and in favor of bidders' unbalanced bidding. Risk-Profit Rate Model through combining the risk parameter and the profit rate improves the accuracy of the risk prediction. On the other hand, there is too much mathematical model in this model and it's very complex to investigate the bidders' profit level, this model is not recommend to use. Comprehensive Risk Parameter Model evaluates the risk and the profit rate in the comprehensive way, which is the simplest and most convenient way to predict the expense of the risk and being widely used.

3 Introduction of the Comprehensive Risk Parameter Model

3.1 Determine Risk Factors' Weight with AHP

There're many kinds of method to evaluate the weight of the risk factors, in which AHP is more convenient and practical. AHP has two steps.

3.1.1 Build the Hierarchy Model and Set Up the Determination Matrix

Classify the risks of the issue and describe their affiliation with the hierarchy diagram. Usually the hierarchy contains three layers: destination layer, criterion layer and program layer.

On the basis of the hierarchy diagram, quantitatively analyze the relative importance of every last indicators and set up the determination matrix $A = \{a_{ij}\}$, in which a_{ij} stands for the relative importance of A_i to A_j. a_{ij} is a number between 1–9 or its reciprocal, and a_{ji} and a_{ij} are in reciprocal relationship $a_{ij} = 1/a_{ji}$.

3.1.2 Hierarchically Analyze and Calculate the Weight of the Risk Factors

Calculate the largest eigenvalue and eigenvector of each adjacent layer with the following steps:

1. Multiply every last element in the same line of the determination matrix, and calculate the largest eigenvalue with the formula:

$$\overline{\mathrm{w}}_i = \sqrt[n]{\prod_{j=1}^{n} a_{ij}}\ (i = 1, 2, 3 \ldots n) \tag{2}$$

2. Normalize the risk factors' weight with the formula:

$$\mathrm{w_i} = \frac{\overline{\mathrm{w}}_i}{\sum_{j=1}^{n} \overline{\mathrm{w}}_i} \tag{3}$$

At last, sum up the matrix of risk factors' weight $W = [\mathrm{w}_1, \mathrm{w}_2, \ldots \mathrm{w_n}]$.

3.2 *Evaluate the Risk Expense with Fuzzy Membership Analysis*

3.2.1 Set Up the Fuzzy Evaluation Matrix of the Risk

Due to the difference of the impact of every part of risk on the comprehensive unit price, we should evaluate the importance of every part of the risk. Firstly, set up an evaluation matrix of risk level $V = \{tiny, middle, great\}$ and ask for 5–10 specialists synthetically evaluating bidders' ability of every part of risk control. Secondly, add up the number of people in accordance with the risk level of every part of risk and set up the fuzzy matrix of the risk $R = \begin{bmatrix} r_{11} & \ldots & r_{1n} \\ \vdots & \ldots & \vdots \\ r_{m1} & \ldots & r_{mn} \end{bmatrix}$, in which $\mathrm{r_{ij}}$ means the probability of risk i to the level j, and $\sum_{j=1}^{n} r_{ij} = 1$.

3.2.2 Calculate the Comprehensive Risk Parameter

Calculate the comprehensive fuzzy matrix by combining the risk factors' weight and the fuzzy evaluation matrix of the risk with the formula:

$$\mathrm{b} = \mathrm{W} \cdot \mathrm{R} = (w_1, \mathrm{w}_2, \ldots \mathrm{w_m}) \cdot \begin{bmatrix} r_{11} & \ldots & r_{1n} \\ \vdots & \ldots & \vdots \\ r_{m1} & \ldots & r_{mn} \end{bmatrix} = (b_1, b_2, \ldots b_n) \tag{4}$$

If $\sum_{j=1}^{n} b_j \neq 1$, then normalize the matrix $\mathrm{b}' = (b_1', b_2', \ldots b_n')$.

When specialists evaluated the importance of the risk, they usually make the judgment with subjective experience. Therefore, in order to reflecting the otherness of the risk level, we should quantitatively analyze and give the weight to the risk level (Yang Xiu-peng and Shen Jie 2009; Zhang Huiming 2011)· According to the importance of evaluation level, we determine the weight of the risk level as

$V = \{10\ \%, 30\ \%, 60\ \%\}$, and calculate the parameter of risk expenses with the formula:

$$r = \mathrm{b}' \times V^T \tag{5}$$

Combining with the profit calculate the comprehensive risk parameter rate with the formula:

$$\alpha = r \times \tau \tag{6}$$

At last, calculate the comprehensive unit price with the formula:

$$\begin{aligned}\text{comprehensive unit price} = \big(&\text{cost of labor, material, mechanical plant,} \\ &\text{administraion expense}\big) \times (1 + \alpha)\end{aligned} \tag{7}$$

4 Illustrative Example

Take a hypothetical affordable housing project as example, whose construction area is 147,379.98 m^2 and the prospective profit rate is 10 %. We quantitatively analyze the expenses of risk in its subentry project of foundation pit earth excavation.

4.1 Determine Risk Factors' Weight with AHP

According to the preceding part of the text, the risk in the comprehensive unit price of Bidding control price consist of the risk of material cost, the risk of mechanical cost, the risk of administration expense and the risk of profit. The AHP hierarchy diagram see Fig. 1.

Quantitatively analyze the relative importance of every last risk and set up the determination matrix, see Table 3.

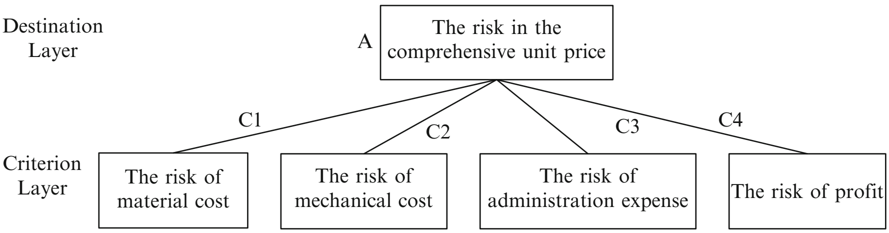

Fig. 1 Hierarchy diagram of the risk in the comprehensive unit price

Table 3 AHP evaluation of the importance of risk

A-C	C1	C2	C3	C4
C1	1	3	6	6
C2	1/3	1	4	4
C3	1/6	1/4	1	1
C4	1/6	1/4	1	1

Calculate the largest eigenvalue with formula 2:

$$\overline{\mathrm{w}}_1 = \sqrt[n]{\prod_{j=1}^{n} a_{1j}} = \sqrt[4]{108} = 3.224 \qquad \overline{\mathrm{w}}_2 = \sqrt[n]{\prod_{j=1}^{n} a_{2j}} = \sqrt[4]{16/3} = 1.520$$
$$\overline{\mathrm{w}}_3 = \sqrt[n]{\prod_{j=1}^{n} a_{3j}} = \sqrt[4]{1/24} = 0.452 \qquad \overline{\mathrm{w}}_4 = \sqrt[n]{\prod_{j=1}^{n} a_{4j}} = \sqrt[4]{1/24} = 0.452$$

Normalize the risk factors' weight with formula 3:

$$\mathrm{w}_1 = \frac{3.224}{3.224 + 1.520 + 0.452 + 0.452} = \frac{3.224}{5.648} = 0.571$$
$$\mathrm{w}_2 = \frac{1.520}{3.224 + 1.520 + 0.452 + 0.452} = \frac{1.520}{5.648} = 0.269$$
$$\mathrm{w}_3 = \frac{0.452}{3.224 + 1.520 + 0.452 + 0.452} = \frac{0.452}{5.648} = 0.080$$
$$\mathrm{w}_4 = \frac{0.452}{3.224 + 1.520 + 0.452 + 0.452} = \frac{0.452}{5.648} = 0.080$$

According to the reckoning, the matrix of risk factors' weight is W = [0.571, 0.269,0.080,0.080].

4.2 *Fuzzy Membership Analysis of Comprehensive Risk Parameter*

According to the matrix of risk level, organize 10 specialists evaluating the bidders' ability of every part of risk control and calculate the probability of each risk to the certain level, see Table 4.

On the basis of Table 4, setting up the fuzzy matrix of the risk $R = \begin{bmatrix} 0 & 0.3 & 0.7 \\ 0.1 & 0.6 & 0.3 \\ 0.6 & 0.4 & 0 \\ 0.6 & 0.4 & 0 \end{bmatrix}$. Calculate the comprehensive fuzzy matrix by combining the risk factors' weight and the fuzzy evaluation matrix of the risk with formula 4:

Table 4 Probability of each risk to the certain level

	Evaluation		
	Evaluation from specialists		
Risk factor	Tiny	Middle	Great
The risk of material cost	0	0.3	0.7
The risk of mechanical cost	0.1	0.6	0.3
The risk of administration expense	0.6	0.4	0
The risk of profit	0.6	0.4	0

$$\mathrm{b} = \mathrm{W} \cdot \mathrm{R} = (w_1, \mathrm{w}_2, \mathrm{w}_3, \mathrm{w}_4) \cdot \begin{bmatrix} r_{11} & \cdots & r_{15} \\ \vdots & \cdots & \vdots \\ r_{41} & \cdots & r_{45} \end{bmatrix}$$

$$= [0.571, 0.269, 0.080, 0.080] \cdot \begin{bmatrix} 0 & 0.3 & 0.7 \\ 0.1 & 0.6 & 0.3 \\ 0.6 & 0.4 & 0 \\ 0.6 & 0.4 & 0 \end{bmatrix} = (0.1229, 0.3967, 0.4804)$$

Give the weight V = (0.1,0.3,0.6) to the risk level, and calculate the parameter of risk expenses: $r = b' \cdot V^T = (0.1229{,}0.3967{,}0.4804) \cdot (0.1{,}0.3{,}0.6)^T = 0.4195 = 41.95\,\%$

The prospective profit rate is $\tau = 10\,\%$, calculate the comprehensive risk parameter rate with the formula 6: $\alpha = r \cdot \tau = 41.95\,\% \times 10\,\% = 4.2\,\%$

5 Conclusion

According to the characteristic and applicability of every kinds of risk quantizing method, this paper focuses on the Comprehensive Risk Parameter Model. There're three steps in the Comprehensive Risk Parameter Model: determine risk factors' weight with AHP; evaluate each part of risk with the fuzzy membership analysis and set up the evaluation model of expense of risk.

Integrating the advantages of quantitative analysis and qualitative analysis, this model introduce the fuzzy theory analysis to the question that AHP pay too much attention on the weight of the factors. This model effectively solves the problem that the expense of risk evaluation is lack of quantitative analysis and depends too much on the risk parameter released by the construction department. On the other hand, this model combines the profit rate with the risk evaluation, which improves the accuracy and scientificity of the comprehensive unit price in the bidding control price.

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Construction and Application of Intrinsic Safety Management System in Coal Mine

Guang-qiao Lin, Jin-wang Zhang, and Yan-liang Wang

Abstract The long-term development of the intrinsic safety management system has been reviewed, and the construction of intrinsic safety management systems in the coal mining industry is summarized based on the existing systems at home and abroad. Moreover, the basic patterns and the pre-control measures of risk control management are described, and the application of them in the coal mining industry is also presented in detail. At last, the article proposed the methods of constructing the intrinsic safety management for the coal mining industry, so that the safety of production can be guaranteed.

Keywords Intrinsic safety • Risk pre-control • Safety management

1 Introduction

The so-called "Intrinsic Safety" refers to the system or device designed to eliminate hazard factors or reduce the risk to an acceptable range, so that accident does not occur in the system in the production process (Wu Zhigang 2008). For example, intrinsically safe equipment, even in the event of human error, can guarantee the personal safety of the operator. Intrinsically safe system is required for personnel, equipment, and the environment. All rules and regulations must be safe and reliable.

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In recent years, coal mine safe production problem has been a widespread concern at domestic and international mines. Coal mine accidents occur frequently in China. The fundamental reason is the lack of a system of safety management, in addition to complex coal mining environment. To realize intrinsically safe coal production system, there is still a long way to go (Xu Zhengquan et al. 2006). In order to achieve the intrinsic safety of coal production, we must identify potential risks and safety hazards in the production process, change the traditional ideology of the coal mine safety management, and use scientific management methods.

2 The Construction of Intrinsic Safety Management System in Domestic and International Coal Mining Enterprises

The development of the mining safety management system in foreign countries underwent roughly three stages: experiential management, systems management and risk pre-control management. Risk pre-control management is the highest stage of development of the safety management. Its goal is to realize "all risks be avoided, all accidents be controlled", and reduce the potential accident and danger in production to an acceptable range. National Occupational Safety Association (NOSA) of South African's safety management system aims at three objectives: safety, health and environmental protection, emphasizing the ideology of humanized and continuous improvement. It has effectively controlled the risks that exist in production. Occupational Safety and Health Management System (OSHMS) aims at occupational safety and health, combined with overall management functions. It has become the internationally accepted occupational health and safety system. However, the OSHMS is just an overall framework, coal mining enterprises need to develop and implement their own systems according to their actual situation.

China's coal mine enterprises have accumulated a wealth of the experience in the safe production, and have achieved some success in the long-term production process. Shenhua Group is always adhering to "four insistences", "four strengthenings" management philosophy, safety management has been embodied throughout the whole production procedure (Guo Hanjun and Zhang Shengli 2007). Fushun Open Pit has formed a "three & five" safety management to achieve a combination of traditional and modern management patterns. Xinwen Mining Group adheres to "operational behavior, management responsibilities, operating environment, hazards prevention", explores the implementation of the intrinsic safety management (Zhang Junxue 2009). Xuzhou Mining Group aims at "Excellence in intrinsic safety", meanwhile it strengthens the construction of a mine safety culture, improved mine intrinsically safe system in practice (Zhao Chaoyi 2002). Based on the theory of system engineering, which takes human, machinery and environment into consideration, Kailuan Group has established an offline intrinsic safety management system (Liu Haibin and Li Guangrong 2007).

There are similar concepts and formula of long-term safe management mechanism and intrinsically safe enterprises in foreign countries. United States and other major coal-producing countries have a very low mortality. For example, the United States has an annual output of more than 1 billion tons of coal in 2005, only 25 people died. There is only one severe gas explosion occurred in the time period of more than 5 years. The number of deaths in coal industry is much lower than that of the construction and other mining industry. They have established an effective safety management system and achieved a stable production safety. Zero death has been the production safety goal to encourage continuous improvement of production safety. Although many domestic coal companies have recognized the importance of scientific safety management, it is still in the early stages of exploration. The safety management stays ideal, and has not yet been achieved by a certain method.

3 The Establishment Coal Mine Intrinsic Safety Management System with the Risk Pre-control as the Core

3.1 History of the Development of Intrinsically Safe Management Theory

The development of intrinsically safe management went through three main stages: the post-accident management phase was formed before the 1930s; real-time control phase began to form after the 1930s; preventive control phase was formed in the 1950s. As the three stages identify it's centers based on machines, people and management respectively, they also called: experience management, system management and risk prevention management. Risk prevention management system is considered as a more scientific management system currently. In our country, especially in the coal industry, under the serious security situation, the risk prevention got an increasingly publicity. Under the leadership of the State Administration of Coal Mine Safety Supervision Bureau, Shenhua Group and many domestic research units carry out joint research, to establish a coal mine intrinsic safety management system with risk pre-control as the core (State Administration of Coal Mine Safety Supervision Bureau 2006). The main features of this system are: (1) employee with high safety awareness, rich safety knowledge and strong ability of first-aid; (2) high level of mechanization with security and fault detection, and high reliability of equipment security; (3) a reliable system of coal mine production which emphasizes , the favorable production environment, and the strong ability of resisting disasters; (4) risk prevention as the center, to optimize existing management systems and achieve the intrinsic safety of mine production (Li Ruijing and Wang Dongjiang 2005).

3.2 Meanings of Risk Pre-control Management

The meaning of risk pre-control can be simply summarized as identifying all production risky factors that may cause accident prior to taking preventive measures to effectively prevent accidents and minimize risks that may exist in the production. The establishment of the risk pre-control system must be combined with the actual production, taking full account of all possible risky factors in the system to identify the primary and secondary risks of the various factors, and discuss the need of creating a prevention mechanism rely on technical means. In addition, we must take the interaction among the job site, equipment and environment into consideration, establish and perfect the rules and regulations, and improve the safety supervision and management security system.

3.3 Risk Pre-control Management Methods Research

Study the theory of intrinsic safety system in coal mine. We have integrated various factors such as people, equipment and environment into our system in coal mine to form a reliable intrinsically safe system. By analyzing coal mine accidents, we identified shortcomings and deficiencies in the risk management system, and improved the theoretical system. Considered China's coal mining complex geological conditions, we refined intrinsically safe standards, established a set of specific operational risk pre-control management system to guide the safe production of coal mining enterprises.

Establish the coal mine intrinsic safety management information system. Sound management information system can help to achieve objectives of the coal mine intrinsic safety management efficiently, and provide a strong guarantee on the method (Li Pingcai et al. 2005). The overall level of China's mining information is much lower than that of other industries, hindering the development of safe and efficient production of coal mine. Although some domestic coal mining enterprises have been equipped with data collection and risk detection system, most of them are limited with local system. For the needs of accessing to a specific data in a huge management system accurately, and providing a powerful guarantee for the safe and efficient production, it is necessary to establish and improve coal mine intrinsic safety information platform.

To form a sound safety accident risk assessment model. According to the different uses of the production system, the content of the risk assessment requirements are different, but the risk management model is basically the same, as shown in Fig. 1. Risk management system includes the whole process in the model, but the main three elements are within the dotted line (Wang Qin 2005; Chen Wei-min 2007; Li Yuan et al. 2007). The risk management standards should be determined before the risk assessment, and then considering the various factors, they will be adjusted to more site acceptable level. During the development of standards, the potential consequences of risky factors must be fully understood (Wu Zongzhi 2007).

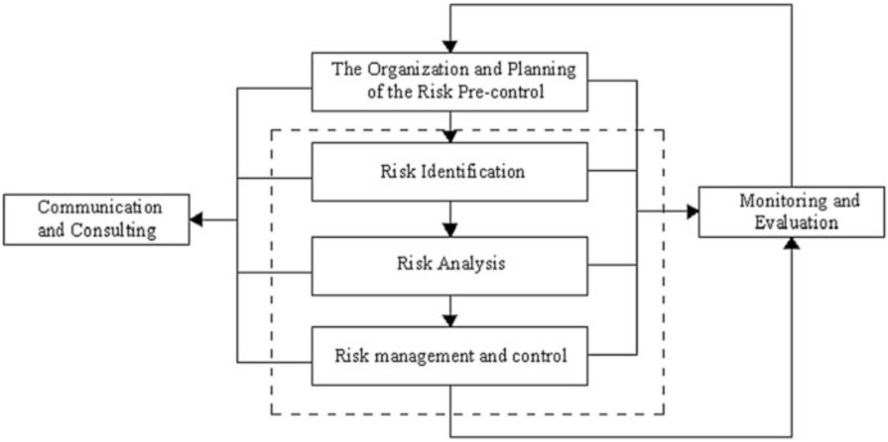

Fig. 1 Risk pre-control management process model

4 The Practical Application of Risk Pre-control Management in Coal Mine

4.1 Event Tree Analysis and Fault Tree Analysis

Event Tree Analysis (ETA) is an analysis method tracking from source to results, based on the operation research and the probability theory. The method is one of the stipulated analysis techniques of China's National Bureau of Standards. The basic principle is: During the whole process of changes from the initial source to the final result, each of the intermediate links is divided into two branches: "Possibles", and "Impossibles", then the two branches are analyzed as initial events, until you get the final result. The event tree analysis of the process of coal mine safety accidents which is based on the "people, material, machines and environment" integrated system is good at analyzing all aspects of the reasons and results.

Fault Tree Analysis (FTA) is just contrary to ETA, it is a logical analysis method sourcing the results to the causes. It analyzes reasons of related events occurred step by step from reverse consequences. The fault tree analysis describes the dynamic process of the accident, and helps to find out the direct and indirect reasons of the accident, as well as a combination of a variety of reasons. Using fault tree analysis of coal mine safety accidents could help our analysis from two aspects. Firstly, from the perspective of qualitative analysis, it is able to distinguish primary and secondary reasons of the accident and find hidden dangers that might be omitted before. Secondly, from the quantitative analysis aspect, it can predict the probability of an accident. Now, FTA method has become the most prevalent method of system analysis for its convenient and strong functions (Lin Boquan and Chang Jianhua 2006).

By the gas explosion accident tree we can clearly find the direct and indirect reasons for the gas explosion as well as the condition under which the accident occurred. The reasons such as a huge amount of "alternatives" in the structure of the fault tree, the improper operation of personnel and the poor condition of devices caused the gas explosion accidents. Using the fault tree to analyze the reasons for the gas explosion accidents, we can take appropriate control measures to reduce or even eliminate the coal mine gas explosion accidents.

Event Tree and Fault Tree Analysis methods can describe the accident causal relationship succinctly and vividly, and find the security risks existed in the system, and thus they can help in the system designing and safety technical measures developing. Also, they are very important analysis methods in security system engineering. They are suitable for the major coal mine safety accidents forecasting, analysis and evaluation, such as management of coal mine gas, fire, water inrush and other major natural disasters. However, the two analytical methods have drawbacks, especially if the system is too complicated, a quantitative analysis will be too difficult. Most of our safety evaluation agencies are only able to do qualitative analysis and evaluation of coal mine accidents with these methods.

4.2 Job Safety Analysis

Job safety analysis (JSA) is a widely used, simple and effective method of risk assessment (Liu Jie 2011). Table 1 shows the risk management table of Shenhua Group Shangwan coal mine's fully mechanized long wall mining team. It is an example of risk pre-control management using JSA. From the Shangwan coal mine, the formulation of each job should have a safe working procedure, so that the employees engaged in specific tasks can accurately understand the task risks and risk control methods.

5 Conclusions

Realizing coal mine production safety, preventing and reducing coal mine accidents, and ensuring the safety of the lives of miners are irreversible trends in the development of coal industry. It is essential in practice and significant in history to establish an intrinsic safety management system in the coal mining industry. To achieve the goal, we should not only have a clear picture of the current situation of production safety in the coal mining enterprises in China, but also learn from the existing advanced safety management methods. Moreover, the experience cumulated from

Table 1 Risk management table of Shang Wan coal mine mechanized coal team

Task		Pre-production preparation	
Process		***Checking the harmful gases checks and recording***	
Hazard sources and hazard factors		The gas inspector failed to check the concentration of harmful gases. Lacking of inspection and other phenomena existed	Gas inspection failure of the equipment
Type of risk		People	Equipment
Risk and its consequences		Failing to detect over-limit harmful gas in time caused asphyxia, harmful gas poisoning, gas combustion or explosion	Can't operate an accurate reading or detect harmful gases overrun, causing hypoxic apnea, harmful gas poisoning, gas burning or explosion
Risk assessment	*Possibility*	K2	K2
	Loss	A6	A6
	Risk value	12	12
	Risk level	Moderate	Moderate
Management Objects		Part-time gas inspector	Optical gas detector
Management standards		1. Part-time gas inspector detected concentration of gas and carbon dioxide in working face, as well as the carbon monoxide in the upper corner of working face twice each shift 2. Detection location should be recorded specifically. The monitoring intervals should be distributed evenly 3. Records must be completed timely after each inspection, and the writing should be clear	Optical gas detector has completed components, opened circuit, clear spectrum, smooth gas flow and no leaking; the diameter of drug particle is 3–5 mm, and there's no caking or color changing
Direct management staff		Class captain	Class captain
Regulatory Authorities		Safety Supervision Department, ventilation team	Safety Supervision Department, ventilation team
Main supervisory staff		Security supervisor, gas inspector	Security supervisor, gas inspector

(continued)

Table 1 (continued)

Task	Pre-production preparation	
Management measures	1. Gas inspectors and security supervisors are responsible for overseeing the working face gas inspection, and identifying problems in time	1. Gas inspectors must check the optical gas detectors and auxiliary tools and replace the improper ones in time before going into the well
	2. Other qualified gas inspectors must be arranged to continue the work if on-duty gas inspectors leave	2. The ventilation team managers should carry out a monthly check of optical gas detectors, those bad ones should be repaired promptly
	3. The "three counterparts" must be checked everyday by a dedicated gas inspector from the ventilation team	

the long-term management in the enterprises should be taken into consideration. Therefore, the intrinsic safety management system customized for the coal mining industry in China can be established, and the intrinsic safety can be finally realized.

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Risk Analysis of Commercial Bank Loans to Local Government Financing Platform Based on Multi-step Fuzzy Comprehensive Evaluation

Xing Bi and He Zhao

Abstract Risk analysis of commercial bank loans to local government financing platform has important theoretical and practical significance. By analyzing influence factors of the loans risk based on the nation, local government and enterprise aspects, this paper establishes risk index system. Then it chooses the multi-step fuzzy comprehensive evaluation method and the AHP (Analytic Hierarchy Process) to build the risk measurement model and makes application analysis of the model. This study helps commercial banks to strengthen risk prevention and management of local government financing platform loans, and promote the healthy development of China's local government financing platform loans.

Keywords Commercial bank loans • Local government financing platform • Multi-step fuzzy comprehensive evaluation • Risk analysis

1 Introduction

China's local government financing platform makes great contribution to speeding up the pace of infrastructure construction, and strengthening the government's ability to take advantage of local resources (An Guojun 2010).

Data from the CBRC (China Banking Regulatory Commission) in January this year, local government financing platform loans has been up to 9.2 trillion, accounting for 13.8 % of the outstanding loans of the banking sector. 35 % of the platform loans coming due in 2012–2014 three years, the local government platform

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is still in the peak of the debt service. Being the absolute main sources of risk, the platform debt is close to 70 % of the total number of local debt. Bank loans account for 79.01 % of the total local debt, so that the fiscal risk deepens the possibility of higher financial risk.

The purpose of this study is to analyze problems in China's commercial banks for government financing platform loans. Combined with the development of the basic requirements and risk management of commercial banks, it puts forward suggestions and considerations to deal with risks, to elicit the attention of the government and society, and together for commercial banks to generate a favorable internal and external environment. The research has a strong theoretical and practical significance.

2 Risk Analysis of Commercial Bank Loans to Local Government Financing Platform

Peng Haijiao thought that the rapid expansion of the scale of local government financing platform and vicious competition among the banks resulted in excessive bank credit, gradually increased capital leverage ratio (Peng Haijiao 2011). Chen Yan Jia thought the excessive bank credit funds into local government financing platforms may make macro monetary policy adjustment more difficult and limit the room for adjustment of the monetary policy (Chen Yanjia 2010). Desheng Dash Wu and Lius A. Seco proposed the use of the balanced scorecard to evaluate the commercial bank credit risk (Desheng Dash Wu and Seco 2009). Ying Shubai and Doowo Nam made detailed analysis of the regulatory structure of China's banking sector (Yi Shubai and Doowoo Nam 2009). Ju Mingli achieved a combination of qualitative and quantitative by using fuzzy comprehensive evaluation method with the analytic hierarchy process to deal with the multi-factor fuzzy and subjective judgments (Zhang Mingli and Jiang Ming 2008).

The fuzzy comprehensive evaluation method proposed by Professor L.A. zadeh in 1965, is usually used to indicate the uncertainty of things (Wu Jinxing and Wang Zongjun 2004). It has many advantages to analyze the risk of commercial banks loans to the local government financing platform. First, it is based on the form of a vector, which is a fuzzy set. So it's more in line with the fuzzy nature of most studies. Secondly, the more levels, the number of indicators in each level will be reduced. The importance and degree of membership can be better determined. Finally, each index weights can be constantly revised according to the change of the object being evaluated.

3 Risk Evaluation Model Based on Multi-step Fuzzy Numbers

3.1 Construction of the Risk Evaluation Index System

By analyzing influence factors of the loans risk based on the nation, local government and enterprise aspects, this paper establishes risk index system. It chooses the multi-step fuzzy comprehensive evaluation method and the AHP (Analytic Hierarchy Process) to build the risk measurement model and makes application analysis of the model (Li Xiaomei 2008).

First, set of local government financing platform loans of commercial banks risk for the target layer, which is represented by A. On this basis, the influencing factors are broken down into three intermediate objectives, namely the national level (B1), the local government level (B2), and enterprise level (B3). Second, the risk factors at the national level mainly focus on economic conditions (C1) and policy conditions (C2) (Li Lin and Suo Yanfeng 2009), the local government level mainly on the credit of government (C3), platform operation and management (C4) as well as the institutional environment (C5). For the enterprise level, it collects risk factors from financial risk (C6), operating risk (C7), and commercial risks (C8). Finally, select 20 indicators items. Categorize and combined them to constitute a factor layer within the criteria above. Factor layer is unified with Di (i = 1, 2, 3 . . .) (Ni Xiangrong 2008), as shown in Figs. 1, 2, and 3.

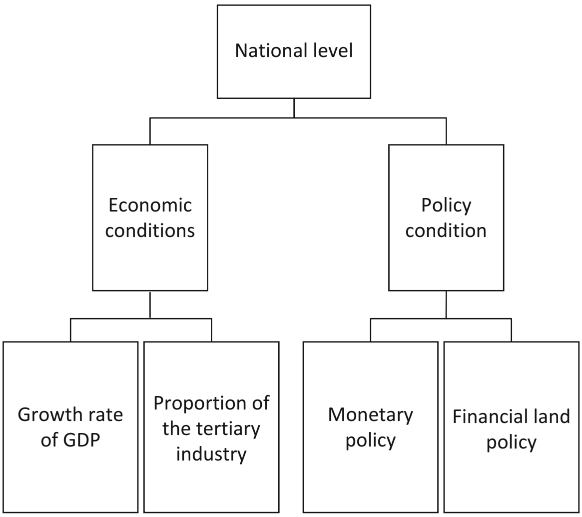

Fig. 1 National level index system

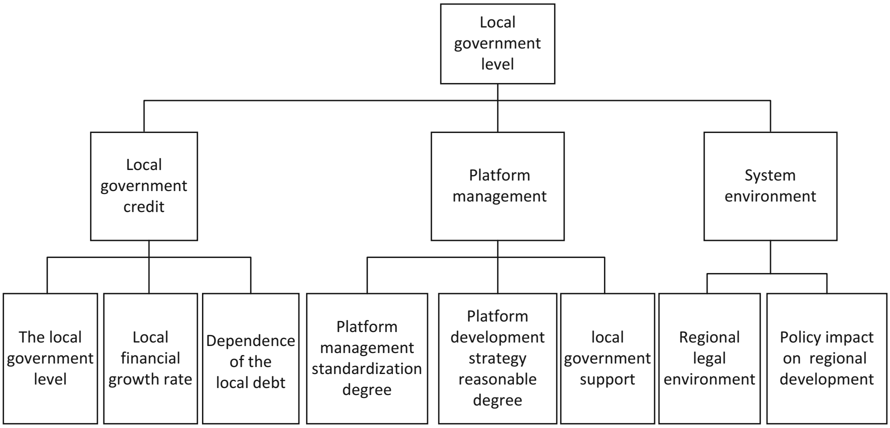

Fig. 2 Local government level index system

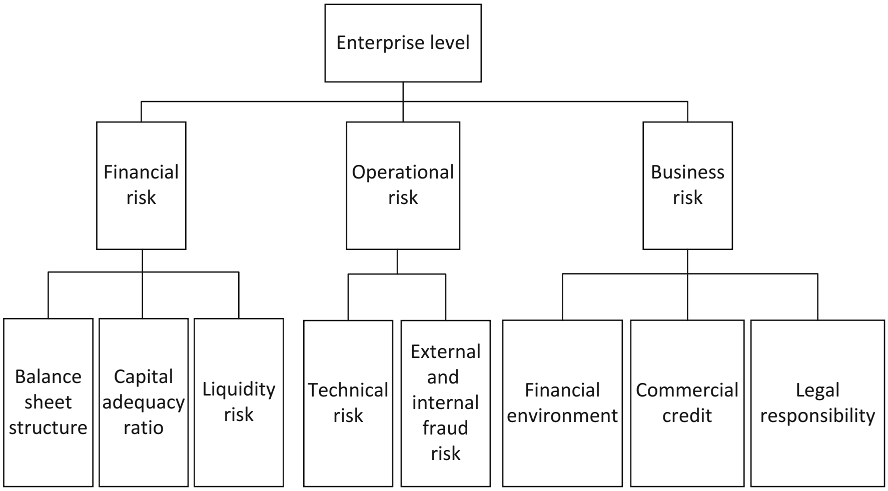

Fig. 3 Enterprise level index system

3.2 Risk Evaluation Model

Fuzzy comprehensive evaluation consists of seven basic steps (Meng Guangwu and Zhang Xingfang 2001):

1. Determine the fuzzy evaluation index set S
   $S = (S_1, S_2, S_3) =$ (National level, Local government level, Enterprise level)

2. Determine the evaluation set V
   Here is the five-grade evaluation and we can determine the evaluation level of the various factors, $V = (V_1, V_2, V_3, V_4, V_5)$ = (very good, good, fair, poor, very poor).
3. Assign the evaluation set U
   The each evaluation corresponds to a value: very good is 10, good 8, fair 6, poor 4, very poor 2, $U = (10, 8, 6, 4, 2)$.
4. Determine the single factor evaluation matrix (membership matrix) R.
   100 % of the affiliation membership is recorded as $R = 1$, no relationship of subordination is recorded as $R = 0$, so the membership value interval is [0, 1].

   The specific approach is: the membership degree of the midpoint of the interval is 1. The membership of the interval between two adjacent midpoints is 0. Connect these two points, we get the membership function. According to the characteristics of the indicators, we conclude that its membership function is a linear function and to meet:

   If $R_{\mathrm{vj}}(\mathrm{r_j}) = 1$, so $R_{\mathrm{vj}-1}(\mathrm{r_j}) = 0$, $R_{\mathrm{vj}+1}(\mathrm{r_j}) = 0$, j = 1,2,3 ... n. n is the number of grade, V stands for grade.
5. Determine the weight of each index set W
   Give corresponding weights for each indicator according to the degree of importance of each index factor, its size and influence should be consistent with the degree of influence of the layer indicators, so is the evaluation factors weights collection, denoted as W:

$$W_k\ (w_{k1} w_{k2} \ldots w_{k3}) \tag{1}$$

and

$$\sum_{j=1}^{m} w_{kj} = 1 \tag{2}$$

There are many ways to determine weights, such as subjective weighting method, objective weighting method, analytic hierarchy process method and so on. The subjective weighting method, mostly because the composition of the subjective consciousness, usually easily leads to disputes; the objective weighting method is the most simple and direct method, but we can't select appropriate data; although the procedure is more complicated, but the theory of AHP is more reasonable, and the mathematical derivation has been proved. In accordance with the relative importance of each indicator and experts' advice, we can confirm the weight value. It can quantify the subjective judgment of people as a simple and practical approach to decision making.

Steps of using AHP to determine the weight:

1. Establish the hierarchical structure
2. Construct pairwise comparison judgment matrix

Table 1 1–9 scale method

Comparative scale	Meaning
1	Two elements compared, the same important
3	Two elements compared, one is slightly more important than the other
5	Two elements compared, one is more important than the other
7	Two elements compared, one is more important than the other
9	Two elements compared, one is extremely more important than the other
2,4,6,8	Intermediate value between the two adjacent analyzing

Table 2 Average random consistent indices

Order	1	2	3	4	5	6	7
R.I.	0	0	0.58	0.89	1.12	1.26	1.36
Order	8	9	10	11	12	13	
R.I.	1.41	1.46	1.49	1.52	1.54	1.56	

Assume that A_k of the previous level is a criterion to the next level elements, B1,B2 . . . Bn. Decision-makers should determine two elements B_i and B_j, according to the criteria A_k, which one is more important, and how much to give a certain value. We use a 1–9 scale method to assign the important degree, as shown in Table 1.

Compare n indicators V_1, $V_2 \ldots V_n$ (n = 1, 2, 3 . . .) with each other, we can get the judgment matrix $X = (x_{ij})_{n \times n}$, Element X_{ij} means the relative importance between elements i and j.

3. Consistency test
   Use eig function in Matlab software to calculate the eigen values of each judgment matrix, determine λ_{max}, and verify the consistency of the matrix (Table 2).

$$C.R. = \frac{C.I.}{R.I.} \tag{3}$$

$C.I.$is the consistency index;

$$C.I. = \frac{\lambda_{max} - n}{n - 1} \tag{4}$$

When the value of $C.R.$ is less than 0.10, the judgment matrix has satisfactory consistency. While the value of $C.R.$ is greater than 0.10, it need to re-adjust the judgment matrix until it is less than 0.10.

4. Calculate the weights of each layer element
   The weight calculation results from top to bottom layer for proper combination, then calculate the weight combination vector elements relative to the overall goal of the lowest level of the hierarchy, consistency and the hierarchical model to test.

6. Calculate fuzzy comprehensive membership value set B (Tang Bingyong et al. 1992).
   The single factor evaluation matrix of n indicators is provided with R_k. By the single factor evaluation matrix R_k and the evaluation set U, we can get the index of the score.

$$B_k = R_k U^{\perp} \tag{5}$$

7. Model (Lin Qingquan 1999)
   The results of the evaluation of the class can be drawn from B_k and index weights W_k.

$$U_k = W_k B_k \tag{6}$$

Set $B = [U_1 U_2 U_3]$ and repeat the calculation steps. Treat the 3 factor subset (k = 1, 2, 3) as single factor on S and confirm the weight according to its distribution. On the basis of the evaluation results of S_k (k = 1, 2, 3), the final model for risk analysis is:

$$U = W \bullet B \approx W \begin{bmatrix} U_1 \\ U_2 \\ U_3 \end{bmatrix} \tag{7}$$

The consolidated degree of membership U is the total score of the evaluation of the object S.

4 Application of Risk Analysis Model in Chinese Commercial Bank

To take the XX Bank Tianjin branch for an instance, we use this risk analysis model to characterize its loans to the Tianjin government financing platform (Table 3) (Li Jitong 2009; Zhang Youjun 2009).

Table 3 Value of macro risk indices

	High-risk	Risk	Basic safety	Safety
Evaluation index	0–45 points	45–60 points	60–80 points	80–100 points
Growth rate of GDP	[0.75,1]	[0.6,0.75]	[0.25,0.6]	[0,0.25]
Proportion of the tertiary industry	[0,10]	[10,30]	[30,60]	[60,100]
Monetary policy	[0.75,1]	[0.6,0.75]	[0.25,0.6]	[0,0.25]
Financial land policy	[0.75,1]	[0.6,0.75]	[0.25,0.6]	[0,0.25]

Table 4 Weight value of the first level indices

	National level	Local government level	Enterprise level	W_i
National level	1	1.4918	2.7183	0.4906
Local government level	0.6703	1	1.8221	0.3289
Enterprise level	0.3679	0.5488	1	0.1805

Table 5 Related indices score

Index	Score index	Weight	Score	Risk score
National level	Growth rate of GDP	0.1322	80	10.576
	Proportion of the tertiary industry	0.0886	68	6.0248
	Monetary policy	0.1214	60	7.284
	Financial land policy	0.1483	60	8.898
Local government level	The local government level	0.0389	90	3.501
	Local financial growth rate	0.0112	95	1.064
	Dependence of the local debt	0.0166	50	0.83
	Platform management standardization degree	0.0137	65	0.8905
	Platform development strategy reasonable degree	0.0325	50	1.625
	Local government support	0.0421	60	2.526
	Regional legal environment	0.0115	60	0.69
	Policy impact on regional development	0.014	60	0.84
Enterprise level	Balance sheet structure	0.0436	40	1.744
	Capital adequacy ratio	0.0695	50	3.475
	Liquidity risk	0.0236	40	0.944
	Technical risk	0.0282	60	1.692
	External and internal fraud risk	0.0166	70	1.162
	Financial environment	0.0421	50	2.105
	Commercial credit	0.0505	65	3.2825
	Legal responsibility	0.0549	70	3.843

Use AHP to determine weights (Table 4).

Based on the calculated risk value and weight coefficient, calculate the numerical overall standard bank risk (Table 5).

Through calculation, the bank comprehensive score is 62.9968 points. The bank's basic security, but some potential risks.

5 Conclusion

This paper analyses risk influencing factors of commercial bank loans to local government financing platform from the nation, local government, enterprise levels. Fuzzy comprehensive evaluation method and analytic hierarchy process are used to construct the risk analysis model. An empirical research of a bank loans to Tianjin government financing platform is carried out. The bank's comprehensive score is 62.9968 points, which means the bank is basic security, but some potential risks. This model has certain operability and the system needs to be perfected in practice, especially in the index selection, weight determination (Zhu Xiaolei 2009). Using this system we cannot only grasp the overall risk, and can obtain daily risk prediction by calculating the data to build time series (Deng Bo 2009).

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Empirical Analysis of Stock Index Futures Risk Management Based on CVaR-GARCH-GED Model

Xiao-bo Zhang

Abstract In this paper, we first introduce the CVaR-GARCH-GED model. The data we choose are HS300 stock index futures, HSI futures and TAIEX futures. We initially run some statistical tests about the data set. Afterwards we estimate CVaR with respective best GARCH model and use the Kupiec's backtesting measure to test statistical adequacy. From the results we conclude that GARCH model and GED can well describe the feature of volatility clustering and fat-tail of return series. And CVaR performs generally well in risk measurement, but as the demand in adequacy and market risk increase, CVaR as a risk measurement needs improving.

Keywords Conditional value-at-risk • GARCH model • Kupiec's backtesting measure

1 Introduction

Value at risk (VaR) is the most well-known risk measurement adopted by the global financial institution. It indicates the worst expected loss at a certain confidence level during the holding period. Initially J.P. Morgan proposed the Risk Metrics to estimate the VaR, but as the GARCH models family was put forward, the methods to calculate the VaR were very much increased.

GARCH family has been widely used in forecasting volatility of financial time series (Antoniou and Holmes 1995; Heynen and Kat 1994; Chong Choo Wei et al. 1999). So and Yu (2006) used the 7 GARCH models in market indices and foreign exchange rates to estimate VaR, finding that a model with fat-tailed error can improve the accuracy of VaR. Angelidis et al. (2004) noted that leptokurtic

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distribution were better in calculating VaR and sample size could influence its accuracy. Daily VaR was calculated again by Giot and Laurent (2003), and they concluded Student's t distribution was better than normal distribution.

But when estimating VaR, we have used approximate calculations, so VaR actually can't alarm a real loss. Rockafeller and Uryasev (2000, 2001) first put forward the conditional value-at-risk (CVaR) and afterwards did more research with CVaR (Rockafellar and Uryasev 2002; Uryasev 2000). Shu-juan Wang and Yuxiang Huang (2005) applied the CVaR-GARCH in estimating CVaR and other risk features of China's stock market. Zong-Run Wang et al. (2010) introduced GARCH-EVT-Copula model and studied the risk of foreign exchange market, and they found optimal investment allocations were alike using different Copulas and confidence levels. Duan and Gong (2011) analysed the risk measurement of the HSI futures return series and the basis sequence, and they concluded that PARCH is the best model in calculating the time-varying market risk CVaR value. Studying the data sample of IF1005 of HS300 Index futures, Lina Wang (2010) demonstrated that accuracy of the CVaR-GARCH-GED model in forecasting earnings under 95 % confidence level is good enough to predict the risk. Yuchuan Huang and Bor-Jing Lin (2004) studied Taiwan stock index futures with 3 models (RiskMetrics, Normal APARCH and Student APARCH) and found the VaR value calculated by the Student APARCH model at high confidence levels is the best.

In this paper, we make empirical analysis about three index futures, which are HS300 index futures, HSI futures and Taiwan Stock Exchange Capitalization Weighted Stock Index (TAIEX) futures. These three stock index futures are very alike regarding the financial environment. But they act very differently in daily trading. Comparing them under the same model of risk management would be helpful in evaluating their performance. In Sect. 2, we introduce the method to calculate the CVaR and GARCH model. In Sect. 3 we run stationary test of data set, autocorrelation and partial correlation test of the sequences and then calculate the CVaR. Afterwards, we use the Kupiec's backtesting measure to test statistical adequacy. At last, Sect. 4 draws a conclusion.

2 CVaR-GARCH-GED Model

Return series embody characteristics as fat-tailed feature, volatility clustering and asymmetric behaviour, which not conforms to normal distribution. There have been many papers verifying that t-error or GED-error distribution is more appropriate in describing financial time series. CVaR can be estimated as follows:

$$\mathrm{CVaR} = -\frac{1}{1-\beta}\int_{-\infty}^{\mathrm{VaR}_\beta} f(x)\,x\,dx \tag{1}$$

Where β is confidence level, x is value of the portfolio and f(x) is the probability density function. If c is the quantile at confidence level β, we use q to express the quantile bigger than c. Then CVaR is:

$$\begin{aligned}
\mathrm{CVaR} = \mathrm{E}\left[p_{t-1} q \sigma_t \middle| p_{t-1} c \sigma_{2t}\right] &= p_{t-1}\sigma_t \mathrm{E}\left[q \middle| q > c\right] \\
&= p_{t-1}\sigma_t \mathrm{E}\left[-q \middle| \alpha\right] \\
&= p_{t-1}\sigma_t \frac{\int_{-\infty}^{-c} - q f(q)\, dq}{f(q)\, dq} \\
&= -\frac{p_{t-1}\sigma_t}{1-\beta}\int_{-\infty}^{-\alpha} q f(q)\, dq
\end{aligned} \tag{2}$$

Where p_{t-1} is the closing price on day $t-1$, and σ_t is conditional variance, f (q) is the probability density function of profit and loss. And in our paper we choose GED-error distribution whose probability density function is:

$$f(q, \nu) = \frac{\nu \exp\left(-0.5\left|z_t/\lambda\right|^{\nu}\right)}{2^{1+\frac{1}{\nu}}\Gamma\left(\nu^{-1}\right)\lambda} \tag{3}$$

Where $\lambda = \left(2^{-\frac{2}{\nu}}\Gamma(1/\nu)/\Gamma(3/\nu)\right)^{1/2}$; ν is a parameter describing tail-thickness; when $\nu > 2$,GED is fat-tailed distribution, when $\nu = 2$,GED is normally distributed, otherwise it's thin-tailed distribution. GARCH model is presented below:

$$r_t = \alpha_0 + \sum\nolimits_{i=1}^{k}\beta_i r_{t-i} + \varepsilon_t \tag{4}$$

$$\varepsilon_t \middle| \psi_{t-1} \sim \mathrm{GED}(0, \sigma_t, \nu) \tag{5}$$

$$\sigma_t^2 = \alpha_0 + \sum\nolimits_{i=1}^{m}\beta_i\varepsilon_{t-i}^2 + \sum\nolimits_{j=1}^{n}\gamma_i\sigma_{t-j}^2 \tag{6}$$

Where r_t is yield series; ε_t is residual; $\alpha_0 > 0, \beta_i > 0, \sum_{i=1}^{m}\beta_i + \sum_{j=1}^{n}\gamma_i < 1$; ψ_{t-1} is information set at time $t-1$.

3 Empirical Analysis

3.1 Statistical Description

The data set we choose is consecutive month contract which can connect different contracts. It's closing price of the contracts during 2010, April 16th and 2013 April 16th.We adopt P to represent closing price, thus the logarithmic yield series is:

$$r_t = \ln(P_t) - \ln(P_{t-1}) \tag{7}$$

Table 1 Basic statistical description

	Std. Dev.	Skewness	Kurtosis	Jarque-Bera
HS300 IF	0.006239	0.007129	5.351943	167.7991
HSI futures	0.005518	−0.268731	5.417984	188.1558
TAIEX futures	0.004833	−0.415276	5.135537	162.5416

Table 2 Augmented dickey-fuller test statistic

Stock index futures		HS300 IF	HSI futures	TAIEX futures
t-statistic		−28.67093	−27.49934	−25.45564
Test critical values:	1 % level	−3.439117	−3.43902	−3.438936
	5 % level	−2.8653	−2.865256	−2.865219
	10 % level	−2.568828	−2.568805	−2.568785
Prob.		0.0000	0.0000	0.0000

First, let's see the basic statistical features of those yield series.

In Table 1,we note that kurtosis of the three series all exceed 3, which means the leptokurtosis, and the skewness not equalling 0 means their non-normal distribution. Further, the Jarque-Bera exceed the critical value 5.991 of Chi-square Distribution (DOF = 2) at 95 % confidence interval. In a word, the yield series show leptokurtosis and volatility clustering.

3.2 Stationarity Test of Data

We then make a ADF unit root test.

In Table 2, we can clearly see that the absolute ADF statistics are greater than each critical value at different confidence levels, which proves the times series to be stationary.

3.3 GARCH Model

GARCH is good at capturing the features of fat-tailed returns and volatility clustering of financial time series. With conditional variance calculated by GARCH model, we can estimate the CVaR. And in GARCH model family, there are some derivatives, such as TGARCH which can reflect leverage effect, EGARCH which can distinguish the effects of good and bad information and PARCH which can also indicate leverage effect

According AIC and SC criterion, in terms of HS300 index futures in Table 3, we deem GARCH model is the most suitable one to describe the conditional variance.

Table 3 GARCH model family

	Parameter	α	β	γ	δ	AIC and SC
HS300 IF	GARCH	0.00000075	0.033381	0.94665		−7.485558
		(1.149704)	(1.905058)	(31.0792)		−7.44123
HIS futures	EGARCH	−0.270384	0.081381	−0.079493	0.980452	−7.743192
		(−0.2802998)	(2.485718)	(−3.695503)	(124.1237)	−7.692640
TAIEX futures	EGARCH	−0.34947	0.062659	−0.13417	0.972666	−8.040745
		(−3.611617)	(2.085609)	(−7.322203)	(119.4369)	−7.990837

Table 4 CVaR at 95 and 99 % confidence levels

CVaR	Confidence level (%)	Max	Min	Mean	Expectation	Actual failure
HS300 IF	95	117.39	38.46	64.23	36.3	59
	99	146.37	51.27	83.72	7.2	23
HIS futures	95	814.66	277.84	460.28	36.3	47
	99	1,069.9	350.6	610.34	7.3	13
TAIEX futures	95	329.16	83.04	151.37	36.9	39
	99	433.25	115.9	211.2	7.4	11

Then with regard to the other two index futures. Only EGARCH can show the significance of coefficient. And the coefficients of the ARCH term are both positive, which indicates good news influences the volatility more than the bad news, there is evident asymmetry.

Once we get the variance described by GARCH model, we can just use the Eq. 2 to estimate CVaR. The results are as below:

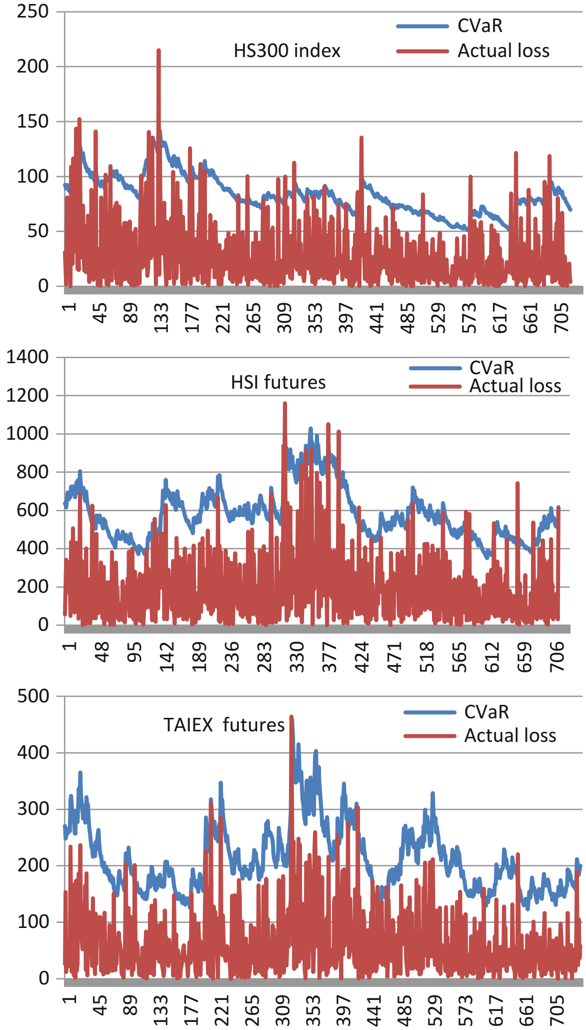
In Table 4, we can see the total days of failure. And we only draw the 99 % CVaR in Fig. 1, which can also tell the accuracy of CVaR. But in order to test the statistical adequacy, we need Kupiec's backtesting measures.

3.4 Kupiec's Backtesting Measures

We use Kupiec's backtesting measures (1995) to test if the actual failure conforms to the model's expectation. If we postulate that the actual loss exceed the corresponding CVaR as a failure and otherwise a successful one. All those tests in reality follow a binomial distribution n, N ∼ B (T, p). The actual probability of success is defined as:

$$p^* = N \div T \tag{8}$$

Fig. 1 CVaR and actual loss



Where N is the sum of successful days, and T is the total days of observation. The null hypothesis is that the expected failure probability $p^* = p$. The likelihood ratio statistic is:

$$LR = 2\ln\left[\left(1 - \frac{N}{T}\right)^{T-N}\left(\frac{N}{T}\right)^{N}\right] - 2\ln\left[(1-p)^{T-N}p^{N}\right] \quad (9)$$

LR follows χ^2 distribution, and its DOF is 1. After calculating the LR for each index futures, we note only the LR for HS300 stock index futures at 99 % confidence level 4.77 smaller than the critical value, which means we have underestimate the risk of HS300 stock index futures. But the other LR values tell that CVaR is still an appropriate indicator of risk management. We deem that it's because the financial environment of HS300 stock market that cause greater volatility. In accordance with other empirical study, the less risky financial environment is, the better CVaR can work.

4 Conclusion

In this paper, we first introduce the CVaR-GARCH model. Then we take the three stock index futures (HS300 IF, HIS futures and TAIEX futures) because they are most alike in terms of financial environment. GARCH model is good at describing the conditional variance. For the HSI and TAIEX futures, the models clearly show a leverage effect. Then we calculate the CVaR and find that it only fails at 95 % confidence level of HS 300 index futures according to Kupiec's backtesting measure. It indicates that in relatively high-risk environment, CVaR is not well enough for risk management. But in general, CVaR can still perform well in risk management such as in HSI and TAIEX futures.

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The Analysis on the Subway Construction of Safety Risk Early Warning Process

Wen-hu Yin, Ge Sun, and Lin-na Wang

Abstract With the rapid development of urban construction, more and more attention on the subway construction has been paid. For subway construction safety accidents occurred in the process of construction, this paper, Taking the subway construction safety risk early warning management of related theory as the foundation, the content of the process of subway construction safety risk early warning and elaborates the significance, analyzed the necessity and urgency of subway construction safety risk early warning process, in order to further lay the foundation to build a subway construction safety risk early warning system.

Keywords Subway construction • Security risk • Warning process

1 Introduction

Due to the rapid increase of population and rapid economic development, cities worldwide are actively promote the construction of the subway, to solve the problem of traffic congestion, the subway system has become the world's main method for cities to alleviate and improve traffic. In this situation, China's urban subway is

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developing in high speed process. Existing more than 40 cities in China are under construction or planning subway and light rail, urban rail traffic facilities such as expected before 2015, will build 1,700 km of urban rail transit, the total investment will exceed 600 billion yuan (Zheng yao and Zhou lingna 2010).

In the process of subway project construction there is a big security risk, various factors lead to security incidents to the state, enterprises and individuals will cause huge economic losses. Enhancing the ability of subway engineering construction safety control, preventing and reducing safety accidents in the process of subway construction, reducing casualties and property losses for maximum extent has become the government and the subway construction major realistic problem urgently to be solved in the various project participants. Through the analysis of the subway construction safety risk early warning process, in this paper, the subway construction risks are strict and effective control, in order to do the subway engineering construction in the process of safety work, more effective prevention of safety accidents, to lay a good foundation for the construction of subway construction safety risk early warning system.

2 Theoretical Analysis

2.1 Theoretical Analysis Abroad

Abroad, related research on early warning, mainly focus on the study of U.S. corporate crisis management and strategies shocking, and Japan's crisis management issues. In the 1980s, Britain's Zishum Summarize the empirical data of population, natural resources, urban, economic and ecological environment interactions in "regional prediction", to predict the social movements, and laid the foundation for the warning to carry out ; The club of Rome as the representative of the future school, trying to establish the model of integrated risk early warning, forming an interaction objective system network between the 12 elements, such as the population, energy, raw materials, environment, water, health, food, education, employment, economic development and so on; AGNET system model analysis tools was researched in U.S. Nebraska in 1982, on the basis of the early warning , implementation of comprehensive the optimization regulation and management decision-making on the social management of the six states in the U.S. Midwest region (Chen qiuling 2010). Abroad constantly improve the risk warning theory, methods and means are constantly updated. Risk early warning theory contains the inherent logic of the early occurrence and development, and the development of risk early warning theory and practice is also further verified and enriches the risk early warning theory, plays a deepening role in the study of the theory of risk warning.

2.2 Domestic Theoretical Analysis

Our risk warning study began in the late 1980s, initially mainly confined to the study of social risk theory. Song Linfei conduct a study on the risk of social development system (Song Linfei 1999); Wu Zhongmin studied on early warning system of social problems (Wu zhongming 1996); Wang Hongbo put forward the social early-warning into social engineering to determine (Wang Hong-bo 2000); Niu Wenyuan and Ye Wenhu discussed the necessity and feasibility of establish stable early warning system of society (Niu Wen-yuan and Ye Wen-hu 2003).

Then the risk early-warning management theory have been applied to the environment, meteorology, aviation, technology and other social fields. In recent years, in the field of underground engineering also has been widely studied and applied. Yuan Cheng through the establishment on the process control and warning system of deep excavation, to the prevention and treatment of deep foundation pit accident, and the establishment of an early warning system, determined of early warning, to study on the theory and practice (Yuan 2004); Fang Jianqin established the disaster corresponding warning system for three basic types of disasters, the local ground pressure disaster, mining subsidence disaster and system three basic disaster (Fang 2004).

Domestic predict the safety risk's levels and trends mainly through the collection of real-time monitoring data, timely grasp the security situation of subway construction, ensure the maximum reduce the occurrence of safety accidents. Development and application of metro engineering construction security early warning system, the construction of subway project environmental safety monitoring and early warning system, has important practical significance to maintain the city daily life and economic operation, which has brought great economic and social benefits.

3 Identification

Including the identification of participants, read related collection of information and expect advice, risk identification, risk screening, the preparation of the risk identification report five steps. Risk identification analysis all aspects of the construction, these aspects include the type the potential risks, the occurrence of place, time and reason, followed by screening and classifying.

3.1 Determine the Participants

According to the specific requirements of the different stages of construction and risk identification, the construction unit to determine the personnel of the project risk identification. The risk management participants of metro and underground engineering include: construction parties, insurance companies and other relevant personnel. The personnel of project risk identification should be familiar with basic information of the construction, and understand the goals and needs of the project risk management, with experience in the construction of Metro and underground engineering.

3.2 Read Related Collection of Information and Expect Advice

Conducting the risk identification of project, we should be extensive collection of project-related information, and seek advices from experienced expert. The main data collected include: the engineering surrounding hydrology, geology, natural and cultural environment, the fire agency regional environmental information; experience in construction of similar projects and the risk of accidents or data; project planning, feasibility analysis and engineering geological survey; engineering surrounding building (structure) building material information; project near the existing subway and underground engineering; engineering level 3, the construction plan, or other relevant documents; may have a business contact or impact relevant departments and other third-party information; relevant information.

3.3 Risk Identification

Risk identification includes the following three aspects:

1. The factors of risk
   We systematically analysis the basic of the project construction information, following by analyzing these aspects, including the stage of engineering construction, activities and all kinds of risk factors existing in the surrounding environment.
2. To establish a list of preliminary identification
   By virtue of the risk research table or check list, we establish a preliminary list of risks, which means that this list should be explicitly listed in the objective existence and potential of various risks.
3. To determine the risk of accidents
   By virtue of finishing in the preliminary list of risks risk factors, we should first analyze associated with a variety of potential loss or impact, and sort out the engineering risk of accidents and their causes.

3.4 Risk-Based Screening

According of results of risk identification, we should again identify project risks, and secondly, we should organize and filter engineering activities directly related to the risk, and finally, we want to remove of risk factors and which of nothing with engineering activities or minimal impact accident, we should remove the risk factors of the accident, which is unrelated or minimal impact on the risk factors, and further identification analysis to determine whether there is risk of missing points.

3.5 The Preparation of the Risk Identification Report

On the basis of the project risk identification and screening, we should list all the list of project risks, according to the specific requirements for the construction of the parties, project characteristics and needs, which is given in a form detailed risk point.

Risk identification is the basis of the security risk early warning factors of metro construction. According to the specific content and features of the subway construction, we firstly consider the likelihood of risk, and secondly, find out the risk factors of subway construction safety, combining with practical, finally, laid a good foundation for further subway construction safety risk warning.

4 Early-Warning

Subway construction safety risk early-warning management is the basis of subway construction safety risk in the comprehensive analysis, warning of the possible dangers, to make a decision on the specific risk, make targeted emergency response plans, to reduce risk in time, make the damage to a minimum (Li Xue-mei 2011). The core content is the most important of prevention for Subway construction safety, control and management to strengthen the safety risk.

Subway construction safety risk early-warning was the course of defining alert, looking for the alert source, analyzing alertness , determining alert degree, and absolving the alert, as shown in Fig. 1.

4.1 Defining Alert

Alert is the abnormal condition in subway construction. Defining alert is the starting point of early warning, and is the basis for the early warning research. Warning meaning is made up of two parts which are warning affair and warning degree, warning affair is In the process of subway construction is mainly refers to the safety status of parts and weak link, warning degree is the weight of the early-warning degree.

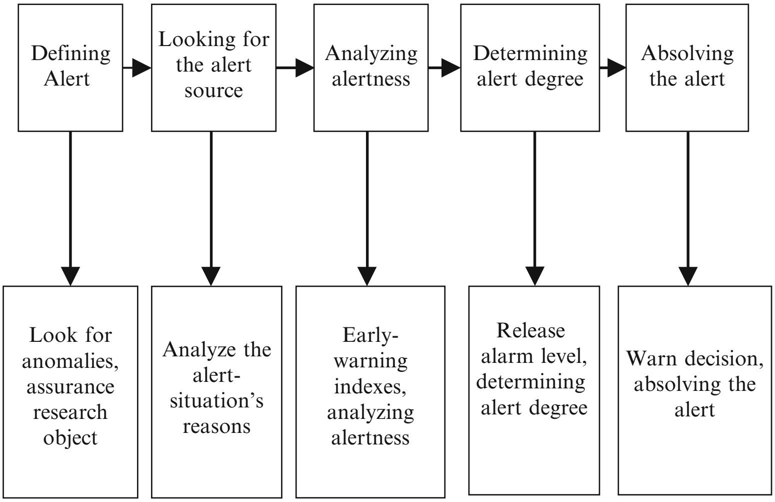

Fig. 1 Subway construction safety risk early-warning

4.2 Looking for the Alert Source

Alert is the abnormal condition in subway construction. Defining alert is the starting point of early warning, and is the basis for the early warning research. Warning meaning is made up of two parts which are warning affair and warning degree, warning affair is In the process of subway construction is mainly refers to the safety status of parts and weak link, warning degree is the weight of the early-warning degree.

4.3 Analyzing Alertness

The alarm index forecast is the key whether the early warning system succeed or not. Warning analysis is a key early warning process, mainly through a series of scientific setting, with strong cautionary warning index, using model analysis, tracking and analysis of the safety risk of the subway construction process. Warning analysis purpose, is to eliminate potential will be looking into the source of risk in the bud, so as to eliminate or alleviate the alarm purpose.

4.4 Determining Alert Degree

Alert degree mainly refers to the need to monitor and forecast in the subway construction safety risk warning content. The degree usually to measure the degree

Table 1 Subway construction safety risk early-warning countermeasures table

Alert degree	Heavy police	Intermediate police	Light police	Non-police
Signal	Red	Yellow	Green	Blue
Analyzing alert source	Contain source	Critical focus	Principal source	Security
Analyzing alertness	Monitor and warn signs	Critical focus	Principal source	Security
Determining alert degree	Absolving the alert	Critical focus	Principal source	Security
Warn decision	Contain source, control initiated emergency	Critical focus, emergency probationary program	Notice, notable changes	Security, notable changes

of alarm. The general according to the nature of things, the severity and the extent of such factors are divided into four grades, namely serious warning (red), the police (yellow), light warning (green) and no warning (blue) (Chen qiuling 2010). Through comparative analysis revealed the warning sign index practical value and the degree of deviation between the ideal value, to determine the index of the interval, and timely forecast of warning degree, analyzing the source and the warning signs, identify alarm, take precautionary measures, such as shown in Table 1.

4.5 Excluding the Alert

The fundamental purpose of metro construction safety risk early-warning is accurate prediction by monitoring analysis and alarm warning sign index of the police sentiment, provide countermeasure of police had found, police in patients, according to the corresponding solutions are put forward control measures, reduce or avoid the construction safety risk, reduce casualties and economic losses.

It appears from the process of metro construction safety risk early-warning, define warning meaning is a premise, is the foundation of early warning research; seek the source of the risk analysis is the causes of exclusion, is basic police patients, is the logical starting point of the construction safety risk warning; analyze the sign is to analyze the related factors, is the foundation of alarm and warning degree; identify alarm is eliminating warning patients according to exclude patients, police is early warning target.

5 Conclusion

In the subway construction process there is a lot of security hidden danger and uncertainty, analyzing the subway construction safety risk early warning process is one of the methods which coped with the problem of subway engineering construction safety control. Formulate scientific and reasonable process of subway construction safety risk early warning can be controlled for safety in the process of subway construction, effectively reduce the subway safety accidents, reduce to the state and society caused serious loss and negative effects; Analysis of subway construction safety risk early warning process to help project related personnel to understand the project progress, whether the construction technology and construction management in line with the expected value, provide the basis for surrounding environment for the timely and effective protection, at the same time to facilitate project management personnel to make effective decisions; Through analyzing subway construction safety risk early warning process, we can further promote the development of subway construction safety risk management, build the subway construction safety risk early warning system, laying the groundwork to develop subway early warning decision making information system.

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The Stochastic Interest Rate Risk Measurement Based on Nonparametric Estimation Method

Jing-jing Li and Bao-chen Yang

Abstract There are many different types of the term structure of interest rate. The estimation methods of these models are usually complex. These problems increase the use-cost of the stochastic interest rate risk measurement and reduce the practicability, correctness and stability of immunization performance. Under Heath–Jarrow-Morton framework, we use nonparametric method to estimate the stochastic durations in order to reduce the influence of model specification error. The nonparametric estimation improves the immunization efficiency of the stochastic duration-matching method. The empirical results show that the method proposed in this paper has more accuracy immunization effect to the interest rate risk.

Keywords Immunization • Interest rate risk • Nonparametric estimation • Stochastic duration

1 Introduction

Interest rate risk is the main risk which the fixed income securities investment must to face. The development of the financial market and liberalization make the market interest rates fluctuate drastically. So the management of the interest rate risk has become a most important question. Although stochastic duration has relaxed restrictions to the term structure of interest rates in theory, the related literatures don't draw a consistently conclusions which about the stochastic duration better than traditional duration. The application limitation of the stochastic duration comes from the complexity of the interest rate term structure model and the highly implementation cost. In practically application, the immunization effect of the

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stochastic duration is inferior to the traditional duration because of the specification errors (Senay Agca 2005; Kaufman et al. 1983; Francois and Moraux 2008).

In this paper, base on the theory of stochastic duration, we use a nonparametric approach to estimate the stochastic duration in the one factor Heath-Jarrow-Morton (HJM) (Heath et al. 1992) model assumption. We try to avoid the influence of the specification error on the immunization effect of stochastic duration in order to get the stochastic duration more accuracy, so that, it can be generally applied in interest rate risk management. Empirical analysis shows that, the method can eliminate the influence of specification error, simplify the estimate process, and make the stochastic duration having more accurate and stable immunization effect.

2 Nonparametric Estimation and Stochastic Duration

2.1 One Factor Stochastic Duration

Au and Thurston (1995) defines the interest rate basis risk for a bond as the proportional percentage changes in a bond's price due to unexpected shifts in the term structure. In the HJM framework, basis risk is given by the forward rate volatility coefficient. The specific definition of type as follows

$$-\frac{\partial B\left(t,T\right)}{\partial f\left(t,t\right)}/B\left(t,T\right) \tag{1}$$

It gets the expression of the Thurston stochastic duration

$$D=\frac{1}{\displaystyle\sum_{i=1}^{n}C_iP\left(t,t_i\right)}\frac{\sum_{i=1}^{n}C_iP\left(t,t_i\right)\left(\int_t^{t_i}\sigma\left(X_t,t,\upsilon\right)d\upsilon\right)}{\sigma\left(X_t,t,t\right)} \tag{2}$$

2.2 Nonparametric Estimation

Base on the known data sets, nonparametric estimation method can get the relationship between the dependent and independent variables directly. Without the formal settings, the estimated effects would not be influenced by the model misspecification problem. There are many nonparametric estimation methods (Aït-Sahalia 1996; Andersen and Lund 1997; Brenner et al. 1996; Ang and Bekaert 2002). The method used in this paper (Jeffrey et al. 2004) basing on a feasible nonparametric estimation method to estimate the general HJM models (Pearson and

Zhou 1999) reduces the related constraint to state variables and random source. So it can be used to estimate a very wide range type of volatility about term structure of interest rate.

Firstly, building the one factor HJM model of the yield to maturity $y(t, t+\tau)$ as following

$$dy\,(t,T) = \alpha_y\,(t,T,X_t)\,dt + \gamma_y\,(t,T,X_t)\,d\,W_y(t) \tag{3}$$

where $\{W_y(t)\}$ is Standard Brownian Motion, X_t is the known variables set which the term structure of interest rate dependent on. This set contains random state variables. In nonparametric estimation process, any observable variables can be as the state variable in the set.

The nonparametric estimation method assumes that the drift and volatility function in the dynamic model (3) only depends on X_t and the term length τ. We can choose multiple variables as the state variables. So (4) also can be written as

$$dy_t\,(\tau) = \alpha_y\,(X_t,\tau)\,dt + \gamma_y\,(X_t,\tau)\,d\,W_y(t) \tag{4}$$

Interest rate term structure form which consistent with this kind of model set is very extensive. This set contains a lot of parametric HJM model's process characteristics.

Now we can establish the dynamic equations of yield to maturity, which contain the equation between the actual yield to maturity and observable yield to maturity, the SDE (Stochastic Differential Equation) of the actual yield to maturity and the SDE of the observable yield to maturity. Specific forms are given by (5)

$$\begin{cases} y_t\,(\tau) = y_t^*\,(\tau) + z_t\,(\tau) \\ dy_t^*\,(\tau) = \alpha\,(X_t,\tau)\,dt + \gamma_{y^*}\,(X_t,\tau)\,d\,W_{y^*}(t) \\ d\,z_t\,(\tau) = m\,(X_t,\tau)\,dt + \nu\,(X_t,\tau)\,d\,W_z(t) \end{cases} \tag{5}$$

where $y_t(\tau)$ is the observable yield to maturity. $y_t^*(\tau)$ is the actual yield to maturity. $\alpha(X_t,\tau)$, $\gamma_{y^*}\,(X_t,\tau)$ are the drift and volatility function in the SDE of the actual yield to maturity respectively. $Z_t(\tau)$ can be seen as the observation errors. We assume that $Z_t(\tau)$ also solves from an SDE. $m(X_t,\tau)$, $v(X_t,\tau)$ are the drift and volatility function in the SDE of the observable yield to maturity respectively. We assume $Z_t(\tau)$ and $Z_t(\tau')$ can have the relativity, $Z_t(\tau)$ and $y_t^*(\tau)$ are irrelevant.

We observe the yield curve and the underlying factor at a discrete number of times n, $0 < t_1 < t_2\ \ldots < t_n = T$, all time intervals t_i to t_{i+1} are equally spaced, that is $t_{i+1} - t_i \equiv \Delta$. Let $\Delta y_i\,(\tau) = y_{t_{i+1}}\,(\tau) - y_{t_i}\,(\tau)$. At each time point t_i, we observe a cross-section of yields at different maturities, $\tau_1, \ldots, \tau_J$. The observable factor X_{t_i} is only depend on term length, but is independent of the observed point t_i.

When $\Delta \to 0$, from the independent condition between $Z_t(\tau)$ and $y_t^*(\tau)$, we can get the conditional expectation formula of $\Delta y_t(s)\Delta y_t(\tau)$, (6)

$$E\left[\Delta y_t(s)\Delta y_t\left(\tau\right)\right] \cong \gamma_y\left(X_t,s\right)\gamma_y\left(X_t,\tau\right)\Delta$$
$$+\, v\left(X_t,s\right)v\left(X_t,\tau\right)\phi\left(s,\tau\right)\Delta \tag{6}$$

where $\gamma(X_t,\tau)$, $v(X_t,\tau)$ are the volatility functions in the SDE of the observable and actual yield to maturity respectively. s, τ are terms, $\phi(s,\tau)$ is $E[W_t(s)W_t(\tau)]$.

In a nonparametric estimate method, we can prove that the observation error's volatility functions which contain in the estimation equations of a kernel regression function at two time points can be ignored. From this condition, we can get a formula which only has the volatility function of the yield to maturity. We can use this relationship to estimate the HJM model's parameters. The local residual sum of squares function corresponding to (6) is the criterion function of the kernel regression estimation, it is seen that

$$Z\left(\gamma\left(X_t,\tau\right)\right) = \int \sum_{i=1}^{n-1}\sum_{j=1}^{J}\sum_{k=1}^{J} K_{h_x}\left(X_i - X_t\right)K_{h_\tau}\left(\tau_j-\tau\right)K_{h_\tau}\left(\tau_k - s\right)$$
$$\left[\Delta y_i\left(\tau_j\right)\Delta y_i\left(\tau_k\right) - \gamma\left(X_t,s\right)\gamma\left(X_t,\tau\right)\Delta\right]^2 d\left(X_t,s,\tau\right) \tag{7}$$

where, $K(\cdot)$ is the kernel function, h_x is the bandwidth in the interest rate's dimension, h_τ is the bandwidth in the term's dimension, $K_h(\cdot) = K(\cdot/h)/h$. $\gamma(X_t,\tau)$ is the volatility function value which has the condition set X_t and the term length.

2.3 The Stochastic Duration Based on Nonparametric Estimation Method

By solving (7) (Jeffery et al. 1999), the volatility function value $\gamma(X_t,\tau)$ can be got.

According to the relationship of $y(t, t+\tau)$ with the instantaneous forward rate $f(t, t+\tau)$, $y(t,T) = -\int_t^T f(t,s)ds/(T-t)$. And using the SDE of the instantaneous forward rate, we can get the SDE of $y(t, t+\tau)$ as follow

$$dy\left(t,T\right) = -\frac{1}{(T-t)}d\left(\int_t^T f\left(t,s\right)ds\right)$$
$$= -\frac{1}{(T-t)}\left\{\left[r(t) + a\left(t,T\right)\right]dt - \sum_{i=1}^{n}\sigma_i^*\left(t,T\right)dW_i(t)\right\} \tag{8}$$

The relationship of $\gamma(X_t,\tau)$ with the $\sigma(t,T)$ is

$$\gamma\left(X_t,\tau\right) = \frac{1}{T-t}\int_t^T \sigma\left(t,u\right)du \tag{9}$$

Then, we can take the stochastic duration basing on nonparametric estimation method. Take $\gamma(X_t,\tau)$ into (2), Specific stochastic duration model as shown below

$$D_\gamma(t) = \frac{\sum_{i=1}^{n} C_i P(t,t_i)\left((t_i - t)\gamma_y(X_t, t_i - t)\right)}{\left(\sum_{i=1}^{n} C_i P(t,t_i)\right)\gamma_y(X_t,\Delta)} \tag{10}$$

where C_i is the cash flow at t_i point. $P(t,t_i)$ is discount function at t point, its term length is $t_i - t$. Δ is a very short interval of time. In the empirical we set it for 0.01 years.

3 Empirical Analysis

3.1 *Empirical Data and Related Parameters Setting*

We will choose the last trading day of each month in the bond transaction data as the sample data. The data is from January 2003 to January 2011. Setting the target bond is a zero coupon bond. Its yield to maturity obeys the initial yield curve, and its duration is in accord with the bond portfolio holding. The face value of the bond is 100 Yuan; target investment value is 10,000 Yuan. Assuming that there is no transaction cost, and we can short selling. With the corresponding investment period length field, sample data are divided into two groups. Bonds are randomly selected from two groups of samples, pair-wise combinations as a hedging tool.

In the basic setting to nonparametric estimation method, using the instantaneous spot rate as the only random state variables, choosing the entire available sample as the known sample set, Bandwidth is 0.01. Our choice of kernel is the commonly used Gaussian, $K(x) = \exp\left(-z^2/2\right)/\sqrt{2\pi}$. Observation interval of time is 1 months.

3.2 *Parameters Setting and Immune Effects*

In order to make the relationship between nonparametric estimation method and the interest risk immunization effect becoming clearer, in this section we will change the different parameters setting in nonparametric estimation method, compare their different immunization effects.

According to the yield curves at January 2003 and January 2008, Table 1 shows the related information of 3-year zero coupon bonds.

Table 1 The related information of 3-year zero coupon bonds

Investment period	Price (Yuan)	Term (year)	Investment value (Yuan)	Yield to maturity (%)
2005.01–2008.01	9,084.78	3	10,000	3.20
2008.01–2011.01	9,004.72	3	10,000	3.49

Table 2 The immunization effects (%)

Parameters setting		The absolute deviation	2005.01–2008.01	2008.01–2011.01
The number of the state variables	1	0.025	86.360	64.440
		0.015	76.620	58.210
	2	0.025	60.390	68.240
		0.015	41.558	54.936
	3	0.025	77.273	42.735
		0.015	64.935	26.496
Bandwidth setting (h_x)	0.1	0.025	88.312	50.129
		0.015	79.870	33.262
	0.01	0.025	86.360	64.440
		0.015	76.620	58.210
	0.0001	0.025	66.234	64.502
		0.015	50.649	60.173
Sample volume	All data	0.025	86.364	64.444
		0.015	76.623	58.205
	Data in 2 years	0.025	66.234	65.665
		0.015	46.104	54.077

Under the different parameters setting in nonparametric estimation method, we can solve the corresponding stochastic durations, and establish different investment portfolios, analyze the immunization effects of these portfolios. We consider instantaneous spot rate, long-term interest rates and yield spread as the selectable stochastic variables. The first two and all three variables will be chosen as the state variables. Using a full set of samples and the samples within 2 years as the known sample set respectively. Set bandwidth as 0.1, 0.01 and 0.0001 respectively in three cases. In each case, the empirical evidence only consider the corresponding condition changes, other conditions using a basic set of conditions which is described in A.

We will get the absolute deviation between the yield to maturity in the investment period and the yield to maturity of target bond. Then we will use the percentage of bond portfolio accounted whose absolute deviation less than 0.025 and 0.015 as the index to analyze the immunization effects. Table 2 shows these empirical results. The absolute deviation is $|y_D - y_{D_0}|$.

Table 2 shows that, either the number of state variables, bandwidth or sample volume, all parametric will bring certain influence to immunization effect of the stochastic duration. The results in Table 2 only show the immunization effects corresponding different parameters setting at two moments, they can't show the immunization effects corresponding different parameters setting at all cases. But these results can display the influences of parameters setting to the immunization effects at a certain extent.

Jeffrey et al. (2004) had pointed out that, choosing instantaneous spot rate $r(t)$ as the only state variable will get a more ideal immunization effect, when the stochastic duration is established under one factor HJM model, and we have enough sample size. The empirical results in Table 2 also show that under this setting we can get the better immunization results than other settings.

As a result, we will choose instantaneous spot rate $r(t)$ as the only state variable, and the bandwidth will be set as 0.01. We will choose a full set of samples as the known sample set.

3.3 Comparison of the Immunization Effects

In this section, we compare the immunization effects of the stochastic duration basing on the nonparametric estimation method with the stochastic durations under three different parametric HJM models.

The three stochastic duration models are shown below.

Stochastic duration base on Ho and Lee (1986) model:

$$D_H(t) = \frac{\sum_{i=1}^{n} C_i P(t, t_i)(t_i - t)}{\sum_{i=1}^{n} C_i P(t, t_i)} \tag{11}$$

Stochastic duration base on Hull and White (1990) model:

$$D_E(t) = \frac{\sum_{i=1}^{n} C_i P(t, t_i)\left(1 - e^{-k(t_i - t)}\right)/k}{\sum_{i=1}^{n} C_i P(t, t_i)} \tag{12}$$

Stochastic duration base on model (13) (Su Yunpeng 2010):

$$\sigma(t, T) = r^{\lambda}(t)\left[\beta_0 + \beta_1 (T - t)\right] e^{-k(T-t)} \tag{13}$$

$$D_{Hu}(t) = \frac{1}{\sum_{i=1}^{n} C_i P(t, t_i)} \sum_{i=1}^{n} C_i P(t, t_i)\left[\left(\frac{1}{k} + \frac{\beta_1}{\beta_0 k^2}\right)\left(1 - e^{-k(t_i - t)}\right) - \frac{\beta_1}{\beta_0 k}(t_i - t)\, e^{-k(t_i - t)}\right] \tag{14}$$

Table 3 The immunization effects (%)

Investment period	The absolute deviation	$D_\gamma(t)$	$D_H(t)$	$D_E(t)$	$D_{Hu}(t)$
1-year	0.025	73.91	83.75	74.68	76.05
	0.015	67.26	66.86	67.98	68.41
	0.005	36.14	32.12	31.93	32.45
1.5-year	0.025	74.87	74.88	74.75	76.56
	0.015	66.42	64.55	66.18	65.57
	0.005	31.17	32.13	31.57	33.04
2-year	0.025	74.54	72.97	72.71	75.57
	0.015	60.28	62.37	61.78	61.16
	0.005	23.67	29.28	35.65	33.98
2.5-year	0.025	73.33	72.58	74.06	75.30
	0.015	64.45	66.87	68.84	69.22
	0.005	39.90	27.11	35.02	31.16
3-year	0.025	75.93	70.35	71.64	72.80
	0.015	58.95	57.39	68.66	68.96
	0.005	38.46	27.84	31.90	29.93
5-year	0.025	75.70	67.22	70.53	68.08
	0.015	63.22	55.12	69.51	66.16
	0.005	30.94	21.78	55.25	41.16
6-year	0.025	76.14	65.86	73.24	71.13
	0.015	61.10	53.82	71.07	68.21
	0.005	33.39	25.92	49.52	34.84

where γ, λ are the parameters of volatility functions. They are all constants. These parameters in different will be estimated by Unscented Kalman Filter method (Yang Baochen and Su Yunpeng 2010).

Table 3 shows the immunization effects of the stochastic duration base on the nonparametric method under three different HJM models. The different row corresponds to different investment period. $D_\gamma(t)$ represents the immunization effects of the stochastic duration base on the nonparametric method, $D_H(t)$, $D_E(t)$, $D_{Hu}(t)$ represent other immunization results.

When computing the immunization effects as the investment period longer than 1-year, we will rebalance the portfolio by selling and buying bonds during the investment period.

From the results in Table 3 we can find that, the immunization effects of $D_\gamma(t)$ are better than other durations at many different investment periods. The investment periods have small influence to the immunization effects of $D_\gamma(t)$. Especially when the absolute deviation is less than 0.025, the advantage of $D_\gamma(t)$ is more obvious in some.

The above analysis shows that introducing nonparametric approach to estimate the stochastic duration can reduce or eliminate the specification error, and improve accuracy and efficiency of the immunization effect of stochastic duration. Compare with the other stochastic durations base on parameter estimation method this method has a better immune effect

4 Conclusion

This paper considers the characteristic of the stochastic duration model, proposes a method to get the stochastic duration under HJM model set.

The nonparametric estimation method has no many harsh conditions to the volatility function, and considers the observation error. It can estimate the value of volatility function accurately. The empirical results show that, the immunization method which is proposed in this paper can improve the immunization effect significantly. This method needn't to complicated set the HJM model volatility function which is contained in the stochastic duration mode. It can eliminate the influence of model errors on the immune effect of stochastic duration, simplify the practical application process of the stochastic duration immunization method, and improve the operability and effectiveness of stochastic duration immunization method. This is a favorable form to apply the stochastic random immunization method.

Of course, nonparametric estimation method also has its limitations, which mainly comes from its dependence on the estimation method and period length the known data covering and other aspects settings. However, along with the unceasing development of our country financial market and the improvement about the nonparametric estimation method, the accuracy of this estimation method will must be constantly improvement. As suggested above, using a nonparametric method to estimate the volatility function, and combine with stochastic interest rate risk measure to immune the interest rate risk will have better application prospect.

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The Research of Quality Evaluation System in Corporate Social Responsibility Report

Zi-jing Wang

Abstract Based on the status and quality of 2011 CSR report in the listed companies of Shenzhen main board, making the further analysis of evaluating the quality of the report and evaluation index, finding the factors which affect the quality of the report, the evaluation index to measure the quality of the merits and rules to evaluate the quality of CSR report to build a quality system model and illustrating the correctness through empirical analysis. Moreover, it is beneficial that improving the quality of CSR report and providing support for practice. Additionally, it is better for them to disclosure and prepares CSR report. Finally, putting forward some political suggestions for improvement.

Keywords Corporate social responsibility • Quality evaluation system • Report

1 Introduction

Corporate Social Responsibility (hereinafter referred to CSR) report is as a means of disclosing corporate social responsibility, directly reflecting the advanced CSR concepts in business and the situation of practicing CSR concretely. It has become an important economic globalization commercial criterion that fulfilling their corporate social responsibility conscientiously and communicating with stakeholders actively. There is no doubt that CSR report accounted for a vital position on the future development of the modern enterprise.

Focusing on the issue of the current existence of quality differences in diversity of CSR Reports and how to prepare CSR reports better, how to become a good perspective for the study of CSR reports, which is how to better provide assistance

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to improve the quality of CSR reports for the purpose of construction the quality assessment system model and through empirical be proved.

2 Research Design

2.1 Design Idea

This paper is as an example of Shenzhen 100 Index constituent stocks CSR Reports from cninfo network, the official website of Shenzhen Stock Exchange, the Securities Times News Network, CASS Corporate Social Responsibility Research Center database, Chinese Listed Companies Social Responsibility Research Center database to collect 2011 CSR report in the listed companies of Shenzhen main board (Shenzhen 100 Index constituent stocks) (Kuang haibo 2010). Getting some financial performance data that reflects—the interests of investors, including revenue, the total annual profits, net profit, return on total assets, the value per share of social contributions and so on. Meanwhile getting some data that reflects the rights and interests of employees and social insurance, including the rate of signing labor contracts, the rate of social insurance coverage, the rate of participation in trade union, the rate of turnover in coverage's the company staff, the contribution rate of social workers, the rate of social accumulation, the rate of investors and other indicators of social responsibility contribution. And acquires some data on environmental indicators (Research and Development costs, improve utilization of renewable energy sources, improve water utilization can be recycled, reusable building materials to improve utilization and reduce coal emissions, reduce meeting travel costs ...) and so on (Zhang Wang and Zhong Hongwu 2011). Data and information in accordance with strict data sources are obtained is as a result of cross-check repeatedly and data and information is accurate and meaningful.

Based on the above theoretical research and data analysis, using a combination of qualitative and quantitative method of research methods, making the research on each social responsibility report in the listed companies of Shenzhen main board and assuming that the quality of reporting is related to the evaluation on each evaluation index in the content of evaluation, making the model of the content of the Social Responsibility Report quality evaluation system and showing that the evaluation system model is correct through excellent CSR report (Shenzhen Overseas Chinese Town Co., Ltd and Vanke A),consequently preparing to make better of grasp the CSR report for the listed companies, to provide some help for improving the quality of CSR report (Zhong Hongwu et al. 2009).

2.2 Factors Affecting the Quality of the Report

The overall quality of statistical data to report quantitative and persuasion has irreplaceable function, which is the elements of a good social responsibility report must have, it is also an important factor influencing the quality and evaluation report. Therefore, impact report quality mainly depends on the evaluation of the content of the disclosure data, enterprises in the corporate social responsibility report disclosed to the public in the following three aspect economics, society, and environment of quantitative and qualitative information (Zhong Hongwu et al. 2011).

1. *Social factors*: Paying taxes according to the law, benefit of the state, the signing of labor contracts, social insurance coverage, to join the union coverage, disclosure rates, taxes, public donations, staff social contribution rate, social accumulation rate, investor's social responsibility, contribution rate of social contribution value per share loss of employees. Reflects the CSR performance index, these are as parts of the quality assessment of a report.
2. *Economic indicators*: Total assets, attributable to shareholders of the parent company net assets, business income, the annual total profit, net profit, attributable to shareholders of the parent company net profit, attributable to shareholders of the listing Corporation's net profit, earnings per share, return on total assets...... As part of the quality assessment report, the earnings per share of the unit is the Yuan, other financial indicators unit is billionth Yuan.
3. *Environmental factors*: R & D costs, improvement of the utilization ratio of renewable energy, improvement of the water cycle utilization rate, improvement of the reuse of building materials usage, reduction of coal emissions, and reduction of conference travel expenses... can be as part of the quality assessment report.

2.3 Quality Evaluation and Analysis of Corporate Social Responsibility Report

Based on the above analysis, the CSR report quality evaluation system is a complicated systematic engineering, objective quality evaluation system is in order to improve the quality of CSR report, in order to provide high quality CSR reports to meet the needs of stakeholders. Therefore, quality evaluation system and method for improving quality of CSR report is consistent (Gao Lifang et al. 2011). In general, a high quality of the CSR report relates to many factors. In the CSR report quality evaluation system, to evaluate the quality of CSR reports depends on the basis of the relationship between the qualities of performance indicators of the quality.

In this paper, according to the excellent CSR report "2011 China listing Corporation social responsibility information disclosure" which was released by the Department of economics of Chinese Academy of Social Sciences (Gong Mingxiao and Zhou Wenhua 2010). A new evaluation index is presented in this paper based on analyzing and summarizing these excellent CSR reports (Sun Hongmei et al. 2011). A positive correlation assumption that quality and the quality evaluation index were made. i.e., The CSR report quality and information authenticity, trustworthiness, continuity, substantive, readability, integrity, balance, comparability, clarity, the amount of information and detailed content, coverage degree, the proportion of negative are positive related (Yang Haiyan 2011).

3 Construction of Quality Evaluation System

Based on the above theory researching and data, using the methods of qualitative and quantitative methods to study the listing Corporation report on social responsibility on main board in Shenzhen, positive correlation hypothesis was made. Evaluation indexes and report quality and evaluation content, constructed social responsibility report quality evaluation system model, and illustrate the correctness of the model of evaluation system through the empirical analysis (Yang Min 2009).

3.1 Quality Evaluation System

Therefore, through the analysis of the above, a good CSR report generally should have this intrinsic property of evaluation content and evaluation indicators (Zhang Zhengyong 2010), the new quality evaluation system must be related to the following specific description of the contents.

Quality evaluation system consists of evaluation content, evaluation index, and evaluation grade (White xiao-shueh 2010), as shown in Table 1.

Table 1 Quality evaluation system model

Evaluation system	
Evaluation content	Evaluation grade
Social responsibility management and index	Excellent (A)
The value per share of social contributions	Good (B)
Corporate governance	Medium (C)
Supervision and performance	Qualified (D)
Financial indicators	Unqualified (E)
Economic indicators	
Environmental indicators	
The sustainable development	
Green environmental protection	
Public relations and social welfare	
Employees rights and interests, health, welfare	
Stakeholders' rights and interests and demand	
Leader's oration	
Independent third-party inspection	
Negative information	

Table 2 Financial, social evaluation index of two companies

Evaluation content	Vanke, A	Shenzhen Overseas Chinese Town Co., Ltd
Total assets	2,962.08	62.76
Operating income	717.83	173.2
Net profit	96.25	3,177,162,768.96
Earnings per share	0.88	0.568
The rate of signing labor contracts	100 %	100 %
The rate of social insurance coverage	100 %	100 %
The rate of participation in trade union	100 %	100 %
The rate of turnover in coverage's the company staff	<1 %	<1 %

Note: The earnings per share of the unit is the yuan, other financial indicators unit is billionth yuan

Therefore, through the analysis of the above, a good CSR report generally should have this intrinsic property of evaluation content and evaluation indicators, the new quality evaluation system must be related to the following specifics

Evaluation refers to the evaluation of the quality of information authenticity, trustworthiness, continuity, substantive, readability, integrity, balance, comparability, clarity, the amount of information and detailed content, coverage degree, Negative proportion and etc (Yao Jialin 2010).

The evaluation grade is divided into excellent (A), good (B), medium (C), qualified (D), unqualified (E) 5 grades.

3.2 The Empirical Analysis

According to the "2011 China listing Corporation information disclosure of social responsibility" which was released by the Department of economics of Chinese Academy of Social Sciences, the main board in Shenzhen (Xia Hong and Li won 2010), China Vanke A (000002), Overseas Chinese town A (000069), investment real estate (000024), Midea appliances (000527), CIMC group (000039), Jizhong energy (000937), China National Accord Medicines (000028), ZTE (000063) released good reports.

Take Vanke A, Overseas Chinese town A as excellent examples to analyze the CSR report.

1. *Analysis of evaluation content*: Data based on Vanke A and OCT A 2011 annual corporate social responsibility report (Liu Fenfang 2011), shown as Table 2 (only the financial and social evaluation index of the two companies were listed in Table 2) and Fig. 1 (the analysis of financial index trend of the two companies), itemized lists, Through the analysis of all content evaluation content, we can find Vanke A and OCT A are comprehensive and the indicators are good.

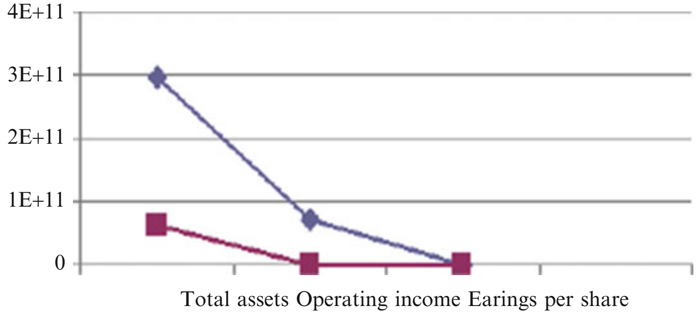

Fig. 1 Analysis of two companies financial indicators trend (Note: Vanke, A, Shenzhen Overseas Chinese Town Co., Ltd)

2. *Correlation analysis*: From Fig. 1 can be analyzed in general (other factors unchanged), financial index is higher, the disclosure of the 2011 annual corporate social responsibility report quality is better. The other two numerical index has reached the degree of excellence, and the numerical indexes Vanke A was higher than that of OCT A.
3. *Analysis of assessment grade*: Vanke A is China's largest housing development enterprises, it's report said from the stakeholders as an entry point to the concept of social responsibility into the design, planning and construction to upgrade the residential quality. OCT A, a long-term commitment to the community to provide quality products, tourism and related cultural industries, real estate and hotel development and management service, also from the social needs, stakeholders and other aspects of social responsibility description. Because Vanke A and OCT A 2011 corporate social responsibility information content is large, respectively from their own company's industry characteristics of the disclosure of information, comprehensive, the key is strong. As the two companies were evaluated by the third party, both revealed the negative information about improving the credibility of the report. The evaluation content and evaluation indexes are outstanding, so they were rated to outstanding (A) by the "2011 China listing Corporation social responsibility information disclosure" (Xu Wei 2009).

In a word, from the above analysis, an excellent CSR report should have better quality evaluation system. A good CSR report can provide reference for the listing Corporations.

4 Research on Innovation

This paper conducted the research results from following aspects, and is of some certain innovation:

First, based on the 2011 annual corporate social responsibility report of main board in Shenzhen ,take 100 Index constituent stocks of the report for the study sample, using the data statistical analysis method and the methods of qualitative and quantitative, further research was done. Through the analysis and induction, factors which affect the quality of the report were found, the evaluation index to measure the quality were got.

Secondly, the assumption of quality evaluation of the system is positively related to quality and the quality evaluation index was made. Based on the above analysis, a model of the quality evaluation system was built. Then the empirical analysis shows that the model is correct.

Finally, put forward policy suggestion on the CSR report in order to enhance theoretical support for the practice. A better disclosure and preparation of corporate social responsibility report provides a powerful reference to improve the quality of social responsibility report.

5 The Research Conclusions and Policy Recommendations

5.1 The Research Conclusion

Although corporate social responsibility report was made only in recent Decades, its development speed is quite fast. Now the implementation of social responsibility was required in western developed countries. Social responsibility in our country is focused on, in the field of theory and practice of social responsibility has also made great progress.

Quality evaluation system model constructed in this paper to evaluate the quality of the analysis results is in good agreement with the actual situation of the 2011 annual corporate social responsibility report of the main board in Shenzhen. Thus proved the correctness of the design quality evaluation system model.

The disclosure of corporate social responsibility report information content is not immutable or frozen, and the disclosure of information was needed to study more by the theory and practice. The diversity of social responsibility of enterprises shows the complexity of its confirmation and measurement, research on the social responsibility standard has only a history of nearly 40 years in the western developed countries, our country only a few years. Scientifically and rationally disclosure of the corporate social responsibility standards will be the future Focus research.

In the future 2–3 years, according to report of international social responsibility, listing Corporation financial report and social responsibility report will be jointed.

5.2 Policy Recommendations

1. *Improving theory system*: Because of the complexity of social responsibility accounting, especially not the breakthrough in the measurement of social

responsibility information disclosure, the lack of corresponding theoretical guidance, no complete theory system was formed. Therefore, in theory, the research of social responsibility accounting theory and method should be Focus on; of course quantitative analysis of social responsibility should be involved. At the same time, the government and research institutions should also pay enough attention to academic research. The theoretical level of social responsibility accounting information disclosure of our country should also be more comprehensive.

2. *CSR report quality*: A well CSR report depends mainly on the quality; it is the key to improve the quality of CSR report. Therefore, the first, the CSR standard system must be establish, formulate specific quality evaluation index system should be involved. The CSR report is mainly according to the norms of corporate social responsibility report, also related to the quality assessment of corporate social responsibility report criterion. That will help to enhance understandability and comparability of a corporate social responsibility report. Secondly, an independent third party certification mechanism of corporate social responsibility report must be leaded in to supervise the social responsibility information disclosure of listing Corporation. Thirdly, improving the participation and information feedback mechanism of stakeholders to enhance the quantitative management of CSR report quality.
3. *Completing CSR management mechanism*: First, perfecting the laws and regulations, improving the disclosure mechanism and incentive mechanism. Second, establishing the sense of social responsibility, the obligation of economic, environmental and social responsibility, the implementation of the CSR should be as a duty in the daily management of the enterprise. Third, enterprises should dare to disclose the negative information and put forward the feasible improvement measures on the consequences of CSR report. More objective presentation publicly shows a well enterprise responsible image. Fourth, increasing of CSR research and propaganda, paying more attention to CSR report form to improve disclosure effect. Fifth, CSR the contents of the report should try to be balanced.
4. To improve the internal organization of social responsibility: First, the system of the social responsibility of the enterprise management and corporate social responsibility system should be established. The social responsibility of internal organization must be constructed, and the ability of corporate social responsibility management must be enhanced. Second, the social responsibility of the enterprise management of the relevant departments and comprehensive management mechanism must be established. Thus the data collection, collation, analysis, reporting system, a written record of complete fulfillment of corporate social responsibility content results should be completed by one department effectively. Third, to establish a long-term mechanism for communication exchange platform, through the mainstream media and various other activities, regularly publish social responsibility information disclosure, negative information synchronously. The improvement of the quality and quantity of the CSR report can be got.

The disclosure of corporate social responsibility report information content is not immutable or frozen, and the disclosure of information was needed to study more by the theory and practice. The diversity of social responsibility of enterprises shows the complexity of its confirmation and measurement, research on the social responsibility standard has only a history of nearly 40 years in the western developed countries, our country only a few years. Scientifically and rationally disclosure of the corporate social responsibility standards will be the future Focus research. In the future 2–3 years, according to report of international social responsibility, listing Corporation financial report and social responsibility report will be jointed.

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Part VI
Management Sciences – Communication Management

Impact of Physical Proximity and Temporal Proximity on Online Impulse Buying in Online Transactions

Xuan Zhang

Abstract Online shopping has become popular worldwide, and online retailers have focused on ways to encourage the impulse buying of customers in an Internet environment. Related studies do not provide conclusions on important website stimuli such as mood-relevant cues. The author first discusses this situation and then classifies these environmental stimuli by using a new criterion. Finally, the author generalizes a hypothesis based on this criterion and explores the influence of physical and temporal proximity stimuli on online impulse buying.

Keywords Environmental stimuli • Online impulse buying • Physical proximity • Temporal proximity

1 Introduction

According to the *Chinese Internet Buying Market Report* for 2009 released by the China Internet Network Information Center, the number of Chinese online buyers as of June 2009 is 87.88 million, which increased by 24.59 million (38.9 %) over the previous year. In the first half of 2009, online buying consumption reaches 119.52 billion Yuan. In major cities such as Beijing, Shanghai, and Guangzhou, where a well-developed online buying market exists, buyer permeabilities (i.e., ratio of buyers to Internet users) are 51.3 %, 52.6 %, and 35.2 %, respectively. By contrast, Japan, South Korea, and the United States have buyer permeabilities of 53.6 %, 57 %, and 70 %, respectively. Given the considerable Chinese online user base and development of the Internet, Chinese e-commerce buyers are predicted to increase significantly in the future. The increasing popularity of online shopping

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among people and the increasing efficiency of support services such as logistics and payment methods will enable the Chinese online buying market to realize its potential.

As online shopping becomes a more mature consumption and retail mode, more companies will consider selling their products on the Internet and seek various means to stimulate the buying impulse of online buyers. Some scholars have suggested rethinking the impulse purchase paradigm in an online environment (Koufaris 2002). Traditional retailers stimulate consumer desire through store appearance, shop layouts, and other methods to create a certain atmosphere within the store (Dholakia 2000). For online retailers, this translates to enriching its website interface. Hence, practitioners and academics should focus more on how to enhance the online purchase experience. Environmental psychology has generated studies on stimuli in an Internet environment and has categorized stimuli as task-relevant or mood-relevant (Parboteeah et al. 2009). However, the pleasure aroused by mood-relevant stimuli cannot be confirmed to affect online impulse buying. In this study, the author tries to explain the stimuli in an Internet environment by category based on physical and temporal proximity, which have been used in the traditional impulse buying research of Hoch and Loewenstein (1991).

2 Stimuli in Traditional Impulse Buying and Online Impulse Buying

Studies on impulse buying, which is an important source of retail profit, have yielded constructive results in the field of consumer behavior and retail (Cobb and Hoyer 1986; Hausman 2000; Rook and Fisher 1995). However, impulse buying in an online retail environment has been merely discussed. Controversy still surrounds the similarities and differences between online and offline impulse buying behavior. Some surveys have found that impulse purchase behavior is more likely to occur in traditional an in-store purchase environment (Madhavaram and Laverie 2004), some other research supports the idea that an online environment is more conducive to impulse purchase behavior (Donthu and Garcia 1999; Eroglu et al. 2001). The former views the product as the main stimulus. Buying impulse can be generated by in-store retailers by stimulating the comprehensive sensory experience of consumers on products (Alba et al. 1997; Rosen and Howard 2000). The latter argues that a shopping environment can stimulate browsing. However, browsing requires the consumer to spend psychological and physical resources (Rook and Gardner 1993). In an online shopping environment, buyers can greatly reduce the cost of these resources. Thus, online retailers have a significant advantage in creating a more positive and hedonic environment that can influence shopping behavior (Childers et al. 2001). Nevertheless, the impact of emotional experience on online impulse purchases is still not clear (Jeffrey and Hodge 2007).

Stern (1962) concludes that traditional impulse stimuli has nine aspects: low price, marginal need for item, mass distribution, self-service, mass advertising, prominent store display, short product life, small size or light weight, and ease of storage (Rosen and Howard 2000). Beatty and Ferrel (1998) classify factors that affect impulse purchases into exogenous and endogenous variables. The endogenous variable includes in-store browsing, positive and negative emotions, and buying impulse. Exogenous variables include purchase environment variables (time available and money available) and individual trait differences as influencing the extent of shopping enjoyment and the impulse buying tendency (Childers et al. 2001). Dholakia (2000) constructed an integrated model named the Consumption Impulse Formation and Enactment model (Rook and Gardner 1993).He reclassifies factors mentioned in previous literature into three aspects: marketing stimuli (product exhibition and promotion), situational factors (consumer finance constraint and mood at the time), and consumer impulsivity trait.

Researchers have classified stimuli related to online impulse buying into task-relevant and mood-relevant (Parboteeah et al. 2009). This division is based on website characteristics identified in environmental psychology (Eroglu et al. 2001). In an online environment, products are manifested and realized through human–computer interaction by IT technology. Therefore, online environmental attributes can affect impulse purchases in the same way as product attributes (Madhavaram and Laverie 2004). Valacich et al. (2007) finds that user reaction to an online shopping environment is often determined by the nature of the buying task. According to the definition of Eroglu (Donthu and Garcia 1999), high task-relevant stimuli include “all site descriptors that facilitate and enable consumer shopping goal attainment,” such as security, download delay, ease of navigation, and information fit-to-task. By contrast, low task-relevant stimuli refer to “to the creation of an atmosphere that has the potential to make the shopping experience more pleasurable” but are “relatively inconsequential to the completion of the shopping task” (Donthu and Garcia 1999). Parboteeah et al. (2009) consider low task-relevant stimuli as mood-relevant cues. Furthermore, stimuli such as pleasantness, visual appeal, and other site appearance characteristics can affect the online experience (Van der Heijden et al. 2003).

A comparison of stimuli research on traditional impulse buying and online impulse buying shows that the former provides considerable emphasis on the role of products as the main stimulus source of the sensory experience that stimulates the buying impulse (Alba et al. 1997; Van der Heijden et al. 2003). Hirschman and Holbrook (1982) note that experiencing products through the five senses is an important part of hedonic consumption, thus confirming the effect of task-relevant stimuli on online impulse buying. By contrast, mood-relevant cues have shown inconsistent results in different research. Parboteeah et al. (2009) finds that mood-relevant cues like visual appeal does not affect online impulse buying directly. Koufaris (2002) found that browsing pleasure from websites is unable to generate obvious effects on impulse purchase behavior. Childers et al. (2001) concludes that the atmosphere created in a virtual environment can also stimulate buying impulse when consumers believe that they have acquired enough sensory information through interactive media. Danthu and Garcia (1999) consider online consumers more impulsive than traditional consumers because of the atmosphere of the online environment. Madhavaram and Laverie (2004) indicates that other environment stimuli exist in in-store environments in addition to product stimuli. Therefore, an online store can also create the same environment stimuli. Eroglu et al. (2001) believes that browsing is closely related to psychological and physical resources that can arouse or constrain impulse buying. Online retailers have more advantages in creating a hedonic environment and atmosphere than traditional retailers.

The author finds that the effect of website browsing pleasure on online impulse buying is still uncertain. Although the stimulating effect of task-relevant cues is obvious, this conclusion does not aid the further exploration of stimuli that affect impulse buying behavior. Task-relevant cues are common in both online purchases and online impulse purchases. This result is similar to the hygiene factor in the double factor theory. Considering that the goal of impulse buying is to increase profits, mood-relevant cues are a more interesting factor than task-relevant cues. This situation shows that researchers should study stimuli that affect online impulse buying. A comparison of traditional and online shopping environments shows other fundamental differences: the space dimension or the distance between consumers and products; time dimension or the distance involved in convenient transaction completion and immediacy of available products. Eroglu, Machleit, and Davis (Donthu and Garcia 1999) conclude that the restrictions imposed by physical and temporal distance on the consumer in traditional impulse buying are eliminated in online transactions. Therefore, consumers are seen as more impulsive in an online situation. A survey by Madhavaram and Laverie (2004) shows that approximately 20 % of the respondents demonstrate online impulse buying behavior, whereas 100 % of the respondents demonstrate in-store impulse buying behavior. Although this perspective is still being argued, this perspective has given the author the inspiration to consider stimuli originating from the time and space dimensions.

3 Influence of Physical and Temporal Proximity on Impulse Buying

The sensory experience of actual products is a focus that has been debated in many studies, and this experience can be explained by physical proximity. In early research on impulse buying, physical proximity, temporal proximity, and social comparison have been proven to stimulate buying impulse (Dholakia 2000; Cobb and Hoyer 1986). The definition of physical proximity by MacInnis and Price (MacInnis and Price 1987) indicates that the actual commodity should be present near the individual's body. This presence enhances the individual's sensory proximity and real experience of the commodity. Thus, the consumer impulse to own this commodity is stimulated. The classic experiment by Mischel (1974) on the delay of gratification by children shows that compared with children shown with photos of material rewards, children shown with real material rewards have difficulties delaying gratification. This result fits the inference of the present study that physical proximity enhances buying impulse. Hoch and Loewenstein (1991) explained the effect of physical proximity from the mental accounting perspectives, which is the core of the prospect theory of Kahneman and Tversky (1979). They believed that all physical proximity factors, including the atmosphere, which stimulates experience, affect buying impulse by the customer's mental account. The individual subconsciously classifies goods that are physically close to him/her as their own. This account belongs to the loss account. Therefore, the loss of these goods will be overestimated. This overestimated loss generates intense anticipation of regret and enhances the impulse to own the goods (Hoch and Loewenstein 1991). Regardless of the theoretical explanation, contact with real goods consistently increases the likelihood of impulse buying. Physical proximity is the key to the product experience in online buying. Therefore, this article adopts physical proximity factors as a type of stimuli.

Temporal proximity factors may also affect impulse buying. These factors have been emphasized more in traditional in-store impulse buying studies than in online environments. In traditional impulse buying research, temporal proximity means that the consumer can own the commodity immediately or longer. A study on self-control states that temporal proximity means that the length of time before the respondents finally obtain the rewards will influence their impulse level (Mischel 1974). A variety of theories explains this concept. In economics, Ainslie (1975) uses the concept of time discount as an explanation: a longer anticipation time of respondents in obtaining the commodity or reward corresponds to a lower value placed on this option in the decision process. Things that can be immediately acquired become more important and attractive. By contrast, owning things immediately decreases respondents' patience in waiting. However, time discount cannot explain the phenomenon that hedonic goods have a more significant time discount than other goods. Hoch and Loewenstein (1991) use the shift of reference points in mental accounts to explain this effect. They believe that the immediate availability of the commodity will move the respondent's reference mental account, thus overvaluing the potential loss of the commodity and generating an intense impulse to own it. On the contrary, owning products for a long period of time leads to insignificant respondent connections with the product and uncertain shifts of mental reference points. Hoch and Loewenstein (1991) explain the differences in hedonic goods by the dynamic shift of the reference point. The overvalued loss will be retained, increased, or decreased over time depending on the type of stimuli. For hedonic products, the loss is initially overvalued greatly (reference point moves a considerable distance) but decreases rapidly with the passage of time. The anticipated regret of not owning the product is also relieved instantly. This phenomenon explains why temporal proximity stimuli are more significant for hedonic products and why attention diversion is a good tactic to decrease impulse. By contrast, research on the role of temporal proximity stimuli in online impulse buying is very limited.

This study is concerned that many physical and temporal proximity stimuli exist in online buying environments, such as product experience and delivery time. This situation is different from the traditional shopping environment. Classifying the stimuli that affects online impulse buying through this perspective is preferred. Another factor is social comparison, which means that the consumer will be encouraged to own the products and will be unwilling to wait because his/her reference groups already own the product. The author believes that except for special reference groups or online communities, no obvious differences exist in the social comparison between online and offline buying. Social comparisons within a special online community are interesting issues to explore.

4 Research Hypothesis

On the basis of the above theory review, the author believes that physical and temporal proximity factors affect online impulse buying (Fig. 1).

The first physical proximity factor is the product's category: virtual products and actual products. Virtual and actual products have different features in real contact with consumers in an Internet environment. Actual products like dresses or mobile phones have higher physical proximities in an in-store environment than in an online store. Virtual products like e-books, downloadable music, or e-tickets do not exhibit any clear difference online or offline. The high online involvement of virtual products, such as items connected to online games and communities, are not discussed in this study because the user experience of these products differs from the sensory experience caused by physical proximity. The second physical proximity factor is user experience, which means that the design style of the product page in an online store emphasizes the usage scenarios or not. For example, photos of the product on the product page present the product, scenarios of the product in actual use, or something similar. This factor is classified as physical proximity because usage scenarios can move mental reference point of the user and stimulate the buying impulse. This has been verified in magazine and television ads.

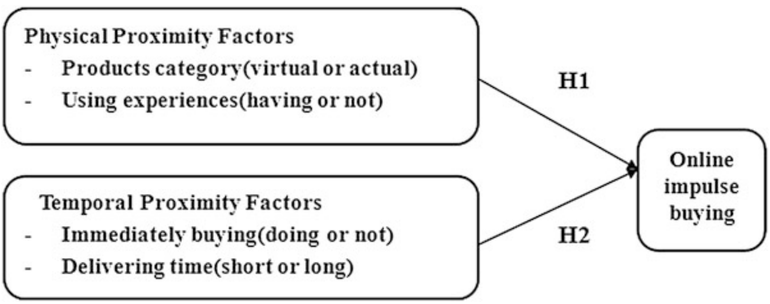

Fig. 1 Research conceptual model

The first temporal proximity factor is immediate buying, which means that the online buying interaction is completed immediately or not. For example, when a customer chooses a product, clicks the button "buy immediately," and finalizes the order, such a customer is immediately buying. By contrast, when the customer chooses to put the product in the shopping cart and goes on browsing, a time lapse occurs before actually placing the order. In these two situations, temporal proximity exists and affects online impulse buying. The delay of ordering may lead to a transaction failure because impulse will wane over time. The buying impulse stimulated by ads is usually blocked by business hours and store distance. Therefore, making a customer wait is unwise. For the same reason, the wait after placing the order, such as that involved in delivering the product to the customer, also blocks the likelihood of an impulse purchase even if the waiting is only anticipated by the customer. This second temporal proximity factor, that is, the delivery time, may be short or long. Delivery time becomes significant in online buying because all products need be delivered.

Finally, the author supposes that these physical and temporal proximity factors will interact with online impulse buying. Based on the above discussions, the author hypothesizes the following:

H1: physical proximity factors positively affect online impulse buying.
H1a: virtual products are more likely to be bought on impulse than actual products.
H1b: products presented by usage scenarios in site pages are more likely to be bought on impulse than products presented by non-usage scenarios.
H2: temporal proximity factors positively affect online impulse buying.
H2a: "immediate purchasing" is more likely to lead to impulse buying than "adding in shopping cart."
H2b: shorter delivery times more likely leads to impulse buying than longer delivery times.

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Moderator of the Microblog Communication on E-shoppers' Purchase Intentions

Jin Yi, Xing-yuan Wang, and Qing Xin

Abstract Academics and practitioners have acknowledged that microblog could provide online consumers with instant information and unique experiences. As a result, the concept of microblog communication has become of great interest to consumers, IT technicians and marketers. Yet, there is limited research on the relationship between microblog communication and Internet users' consumption choice. This study intends to construct the conceptual microblog communication, and gains the empirical results of: (a) customer perceived value and online brand awareness have significantly positive influence on e-shoppers, (b) microblog communication could positively moderate the relationship between perceived value and e-shoppers' purchase intentions, while having no significant moderating effect on online brand awareness and perceived value.

Keywords E-shoppers • Microblog communication • Moderating effects • Purchase intentions

1 Introduction

Currently, many consumers regularly consult Internet sources for information on product categories, brands, manufacturers, and retailers, particularly before arousing purchase intentions about goods or services, regardless of the major

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durable and fast-consumed things. Therefore, the Internet has become a major source for information on every possible brands, attributes, and dealers. Based on this background, the advent of Web 2.0 has created new ways to communicate, collaborate and share content (Enders et al. 2008), such as Facebook, Twitter, MySpace and Microblog are popular online activities in terms of average time spent. Social media and its social networking sites are taken into research consideration ever since their appearance.

Social media, also known as ‘user-generated communication’, now represents a prevalent source of information; it has changed the tools and strategies companies use to communicate, highlighting that information control now lies with the customer (Mangold and Faulds 2009). A study shows that 93 % of social media users believed that companies should have a social media presence, while 85 % of them think that companies should interact with customers via SNS.

Microblog, as the main social media in China from 2007, has rapidly become an influential way to share information and has made China the most active nicroblog market. With the integrated functions of mobile phone’s short message and social networking sites, the number of SINA microblog users in China, which amounts to 0.25 billion by 30th September 2011, jumped to 0.424 billion by 30th September 2012 near to the total number of Internet users. It’s no doubt that there is a wider and open architecture of microblog social network that would transfer individuals’ consumption habits. Considering the characteristics of the microblog social network, we wonder whether the microblog communication could have on the willingness to buy online of e-shoppers and how it affects? Based on the theory of perceived value, this study will take the e-shoppers’ purchase intentions as its research objectives as well as analysis the effects of information filtering, information dissemination and microblog interaction. Hence, the following questions will be answered in this paper. What are the characteristics of the relationship between microblog users? What is the relationship between the e-shoppers’ perceived value, online brand awareness and their purchase intentions? Could microblog communication attributes be used to moderate the e-shoppers’ online purchase beliefs?

2 Literature Review and Research Hypotheses

2.1 Purchase Intentions of E-shoppers

Purchase intention is defined as the degree of customer perception that a particular buying behavior will be performed. E-shoppers, or naming online consumers, tend to be younger, more educated, and have higher income, these characteristics are likely to influence search strategies as well as choice (Kulkarni et al. 2012). Thus, the likelihood of engagement in the behavior increases when individuals’ intentions to perform the behavior are stronger. Individual behavioral intention is determined by attitude, subjective norm, and perceived behavior control (Ajzen 1991). Attitude is defined as an individual's positive or negative feeling about performing the target behavior (Ajzen 1991). According to preview research, attitude has significant effect on adolescents' intention to use SNS. Subjective norm reflects an individual's perception that most people who are perception of how easy or difficult it would be to perform a certain behavior (Ajzen 1991). As people in China advocate the collectivism-oriented social value, they may tend to depend on the recommendations of important people. Therefore, this paper proposed that e-shoppers' purchase intentions would significantly different from others, especially in the context of SNS.

2.2 Perceived Value

Perceived value is a subjective construct that varies between customers, between cultures and at different times (Sánchez et al. 2006). Zeithaml (1988) has suggested that perceived value can be regarded as a consumer's overall assessment of the utility of a product (or service) based on perceptions of what is received and what is given. A valuable exchange is an important argument not only in offline environments but also in online ones (Wu et al. 2012). Past studies have suggested that perceived value is an important antecedent to satisfaction and behavioral intentions (Dodds et al. 1991; McDougall and Levesque 2000). Recent research studies suggest that perceived value may be a better predictor of repurchase intentions than either satisfaction or quality (Cronin et al. 2000).

Perceived value can be analyzed with either a self-reported, unidimensional measure (Gale 1994) or a multidimensional scale (Petrick and Backman 2002; Sheth et al. 1991). An approach based on the conception of perceived value as a multidimensional construct has been gaining ground (Rust et al. 2000; Ruyter et al. 1997). This approach allows this study to adopt three-dimension of perceived value from the research of Sweeney and Soutar in 2001, which is categorized into functional value (economic and quality), emotional value and social value. Wu et al. (2012) found that many of online stores employ discount methods complementary service, and other incentives to deliver superior consumer value of e-shopping, and thereby raise consumers' repurchase intentions (Wu et al. 2012). In addition, research shows that consumer's perceived value in online shopping includes not only more benefits, but also less sacrifice (Zeithaml 1988; Kim et al. 2007). Based on these reasons, this work proposes:

Hypothesis 1. E-shoppers' purchase intentions are positively influenced by their perceived value.

2.3 Online Brand Awareness

Brand awareness refers to whether consumers can recall or recognize a brand, or simply whether or not consumers know about a brand. Brand awareness significantly affects consumer decision-making, especially for low-involvement online goods. Brands that consumers know are more likely to be included in the consumers' consideration set (Hoyer and Brown 1990; MacDonald and Sharp 2000). A known brand has a much better chance of being chosen by consumers over an unknown brand (Hoyer and Brown 1990). Surprisingly, research on brand awareness is scarce. For instance, prior research explores brand awareness's affect on decision-making only through lab experiments at the individual consumer level (MacDonald and Sharp 2000), or they find brand awareness is an antecedent to brand market outcome (Baldauf et al. 2003), or typically focuses on the impact of either advertising or distribution intensity or price promotion on brand awareness (Srinivasan et al. 2008). While causality's direction between brand awareness and market performance begins explored recently (Huang and Sarigöllü 2012). However, there is still little research relating with online brand awareness since online shoppers could be easily confused when facing rich information, particularly when the amount of information greatly exceeds their processing capacity. Jie Gao et al. (2012) explored a new solution based on the role of unconscious thought and showed that unconscious thought moderates the relationship between information quality and consumer satisfaction towards their decision making when shopping experience products online (Jie Gao et al. 2012), and is thus worthy of special attention in the design of e-commerce websites. Inspired from these reasons, this work proposes:

Hypothesis 2. E-shoppers' purchase intentions are positively influenced by online brand awareness.

2.4 SNS and Microblog

Technological progress and innovation have altered the nature of individuals' social networks. In particular, while traditional social networks have involved personal interactions of humans over time (Kimball and Rheingold 2000), interactions are now mediated by computers, which suggest a more impersonal form of online communication. Reports indicate that some adolescents are spending up to 3 h a day on social networking sites (SNSs), leading to reduced time for other activities, including academic, physical, and face-to-face social pursuits (Livingstone 2008). Members of an online network can exchange information and provide solutions from and to different locations across the world in a very short period of time (Lea et al. 2006). Given the importance of social networks and the internet, it is argued that SNSs, a technology embedded in the daily lives of millions of people worldwide (Dwyer et al. 2008), can support brands by developing and maintaining relationships between firms and consumers. Facebook are some of the most popular and frequently visited web sites in the world and, as such, marketers have intuitively recognized their potential in helping to achieve brand objectives (Van Den Bulte and Wuyts 2007). Kaplan and Haenlein (2011) discuss how microblog can generate value for companies during repurchase, purchase and post-purchase marketing stage and present three rules of microblog, which are relevance, respect and return (Kaplan and Haenlein 2011).

Microblog belongs to the big family of social media, which can be defined as the group of Internet-based applications that build on the ideological foundations of Web 2.0 and that allow the creation and exchange of user generated content (Kaplan and Haenlein 2010). Microblog allows users to exchange small elements of content such as short sentences, individual images, or video links (Kaplan and Haenlein 2011). As one of the most popularized social media, microblog has the characteristics of push-push-pull communication and the original contents provided by information sending contributors, which altogether alter the controlling situation of traditional media. On the continuum of social media classification, microblog stand halfway between traditional blogs and social networking sites, and are characterized by a high degree of self-presentation/self-disclosure and a medium to low degree of social presence/ media richness (Kaplan and Haenlein 2010).

Yet, while they rapidly gain interest among consumers and companies alike, there is no evidence to explain why anybody should be interested in an application that is limited to the exchange of short, 140-character text messages (Kaplan and Haenlein 2011). Considering individual differences may interact with effects of communicatory behaviors on individuals' behavioral intentions, this study focuses on the role of microblog communication, one of the most significant concepts that may affect purchase intentions of e-shoppers. People are more likely to expose themselves to information that supports their points of views because they are psychologically motivated to process information that is similar to their personal beliefs (Donsbach 1991; Johnson et al. 2009). Therefore it is reasonable to expect that microblog communication might moderate the effects of customers perceived value and online brand awareness to e-shoppers' purchase intentions. Thus, this study proposes:

Hypothesis 3. The influence of perceived value to e-shoppers' purchase intentions will be moderated by microblog communication.

Hypothesis 4. The influence of online brand awareness to e-shoppers' purchase intentions will be moderated by microblog communication.

3 Research Methodology

An empirical study was designed to test the research framework and the above-mentioned hypotheses. This study focused mainly on the main effects of perceived value and online brand awareness to e-shoppers' purchase intentions and the moderating effects of microblog communication in e-shoppers' social network-

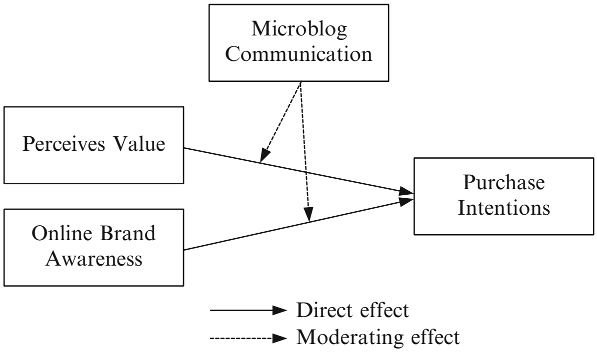

Fig. 1 Conceptual model

ing relationship spectrum. Data were collected through random questionnaires e-shoppers, who spend over 1 h on surfing everyday and are used to shopping from Internet.

3.1 Research Model

Based on the above, this study proposes that perceived value such as functional value, emotional value, and social value, as well as online awareness such as recognition and recall, as noted in the perceived value literature collectively drive intention (as seen in Fig. 1). We propose that: (a) perceived value and online brand awareness collectively influence e-shoppers' intentions to buy; and (b) microblog communication have a moderating effect on purchase intentions toward online buying.

The hypotheses in this research:

H1. E-shoppers' purchase intentions are positively influenced by their perceived value.
H11. E-shoppers' purchase intentions are positively influenced by their functional value.
H12. E-shoppers' purchase intentions are positively influenced by their emotional value.
H13. E-shoppers' purchase intentions are positively influenced by their social value.
H2. E-shoppers' purchase intentions are positively influenced by their online brand awareness.
H21. E-shoppers' purchase intentions are positively influenced by their brand recognition.
H22. E-shoppers' purchase intentions are positively influenced by their brand recall.
H3. The higher frequency of microblog communication is, the greater likelihood will be that perceived value will lead to e-shoppers' greater purchase intentions.

H4. The higher frequency of microblog communication is, the greater likelihood will be that online brand awareness will lead to e-shoppers' greater purchase intentions.

3.2 Measures

An extensive literature review was performed in order to identify the effects of perceive value, online brand awareness, microblog communication, and e-shoppers' purchase intentions. Then, questionnaires were developed. The constructs in the study were developed by using measurement scales adopted from prior studies (as seen in Table 1). All constructs are measured using five-point likert scales with anchors strongly disagree (=1) and strongly agree (=5).

3.3 Data Gathering and Sample

The study data was collected through the questionnaire. The questionnaire began with an introductory statement that asked respondents to administer their own responses, followed by a request for demographic information. Sample was randomly drawn from the population of online consumers who reside within the city in Jinan. The sampling frames consist of randomly selected 378 consumers. The respondents in this study have online shopping experience and their own microblogs (as seen in Table 2).

4 Results

4.1 Reliability of the Data

SPSS 11.5 and Lisrel 8.7 are used to analyse the data. All data is normally distributed. The reliabilities are tested by Cronbach alpha values that are all above the recommended minimum of 0.70. Thus, all of the constructs demonstrate good internal consistency.

4.2 Main Effect Analysis

The overall fit of the model is reasonable. Simultaneous maximum-likelihood-estimation procedures are used to examine relationships among perceive value,

Table 1 Operationalization of constructs

Constructs	Variables	Measurement items
Perceived value (PV)	Functional value	I think online brand has an acceptable standard of quality
		I think online brand has poor workmanship
		I agree that online brand is reasonably priced
		I think online brand offers value for money
	Emotional value	Online brand is one that I would enjoy
		Online brand would give me pleasure
		Online brand would make me feel good
	Social value	Online brand would help me to feel acceptable
		Online brand would make a good impression on other people
		Online brand would improve the way I am perceived
Online brand awareness (OBA)	Brand recognition	Online brand always has a good name
		I find online brand interesting in a sensory way
		Online brand makes a strong impressing on consumers' first visual sense
	Brand recall	Online brand always makes me think whether it is on sales
		Online brand induces feelings and sentiments on special time
		I do have strong memory for some online brand
Microblog communication (MC)	Reciprocity	When I share my information about online shopping on my microblog, I believe that I will receive other information from others' microblogs
		When I share my information about online shopping on my microblog, I expect to get respond from microblog community
		When I share my information about online shopping on my microblog, I believe that my queries for information will be answered in future
		I think that participating in the sharing of information on online brands can improve the reciprocal benefit
	Interaction	I find that my participation in the sharing of information about online shopping on microblog can be advantageous to me and online firms
		Sharing my information about online shopping in microblog improves others recognition to me
		Sharing online brands information on online by firms improves brands' image

(continued)

Table 1 (continued)

Constructs	Variables	Measurement items
	Trust	Microblog gives me a feeling of true and trust
		I have trust in online information from microblog
		The firms' microblog gives me a trustworthy impression
Purchase intentions (PI)	Attitude	I eagerly want to buy the goods online while needing careful consideration
		Compared with traditional channel, I like online shopping
		My intention to engage in online shopping is very high
	Behavior control	Whether purchasing online or not depending on price, brand and risk
		I always read information from Internet before online shopping

Table 2 Description of the respondents

Variables		Frequency (number of people)	Ratio (%)
Age	Below 19	97	25.66
	19–30	126	33.33
	31–40	105	27.78
	Above 41	50	13.23
Gender	Male	221	58.47
	Female	157	41.53
Marital status	Single	112	29.63
	Married	266	70.37
Education	High school	38	10.05
	College	89	23.55
	University	191	50.53
	Graduate	60	15.87

online brand awareness, and e-shoppers' purchase intentions (Table 3). The hypothesized relationships are supported in the estimated structural model (Table 3). Perceive value has significantly positive effects on e-shoppers' purchase intentions, supporting H1. Specifically, functional value strongly positive affects e-shoppers' purchase intentions (0.73), while emotional value weakly positive influences their purchase intentions (0.21) and social value presents stable influence on e-shoppers' purchase intentions (0.43). Furthermore, the effect of online brand awareness on e-shoppers' purchase intentions is also significant, supporting H2. In terms of the online brand recognition and brand recall, the effect of online brand recognition on e-shoppers' purchase intention is 0.63, being equaled to the direct effect of online brand recall of 0.38.

Table 3 Structural parameter estimates and goodness-of-fit indices

Hypothesized paths	Standardized estimate		
	Total sample	High-frequency microblog communication	Low-frequency microblog communication
Perceived value → purchase intentions (H1)	0.67 (12.06**)[a]	0.61 (6.61**)	0.73 (6.19**)
Functional value → purchase intentions (H11)	0.73 (8.11**)	0.51 (4.61**)	0.56 (5.32**)
Emotional value → purchase intentions (H12)	0.21 (9.16**)	0.49 (5.19**)	0.55 (6.15**)
Social value → purchase intentions (H13)	0.43 (7.66**)	0.68 (6.61**)	0.79 (5.89**)
Online brand awareness → purchase intentions (H2)	0.58 (4.96**)	0.72 (12.21**)	0.23 (1.61)
Brand recognition → purchase intentions (H21)	0.63 (7.12**)	0.59 (9.61**)	0.32 (4.19)
Brand recall → purchase intentions (H22)	0.38 (4.33**)	0.31 (4.98**)	0.57 (3.83)
Fit statistics (N = 378)	$\chi^2 = 78.17$ (p < 0.001, df = 39) χ^2/df = 2.004 GFI = 0.9745, CFI = 0.9556, RESEA = 0.0597	$\chi^2 = 52.39$ (p < 0.001, df = 39) χ^2/df = 1.343 GFI = 0.9458, CFI = 0.9916, RESEA = 0.0548	$\chi^2 = 43.17$ (p < 0.001, df = 39) χ^2/df = 1.107 GFI = 0.9182, CFI = 0.9216, RESEA = 0.0610

**Denotes $p \leqq 0.05$
[a]The value in the parenthesis is *t* value

4.3 Moderation Analysis

To examine the moderating effect of microblog communication, the sample is divided into two groups, which are high-frequency microblog communication (keeping online all the time at any terminals, such as computer, tablet, laptop, mobile phone and so on.) and low-frequency microblog communication (occasionally send, forwarding or comment microblog), and are subsequently used for testing the casual relationships. As seen in Table 3, for the high-frequency microblog communication group, all hypothetical relationships are significantly positive. For the low-frequency microblog communication group, the effect of online brand awareness on purchase intentions is not significant, while perceived value on purchase intentions is positively significant. Overall, H3 is supported for both groups, but H4 is only supported for the high-frequency microblog communication group. The results indicate that the moderation effect of microblog communication on the path of online brand awareness to purchase intentions does not exist—that is, H4 is not supported. However, the moderation effect of involvement on the path of perceived value towards purchase intentions does exist, supporting H3.

5 Conclusion

This study not only reveals the effects of perceived value and online brand awareness on e-shoppers' purchased intentions, but also shows moderating effects of microblog communication on the relationship between perceived value and purchase intentions. Moderation analyses provide insights regarding the effect of microblog communication on e-shoppers' perceived value which induce their online purchase intentions. In addition, recognizing the little importance of microblog communication on online brand awareness, the findings suggest an implication on branding strategies for online brands to build up their sustained competitive advantages through improving intrinsic abilities as well as caring for the Internet social media.

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Study on Customer Interpersonal Skills, Normative Participation and Customer Performance in Service Situation

Yuan Gao and Qin-hai Ma

Abstract The effect of customer's interpersonal skills on customer normative participation and customer performance (including customer satisfaction and positive behavior post purchase) was investigated by the method of demonstration, and the complicated relationships between these variables based on structural equation model were discussed. The results show that the customer's interpersonal skills have significantly positive effect on customer normative participation, satisfaction and positive behavior post purchase, and reveal the influence of the customer interpersonal skills on his behavior decision and the finally service evaluation during the service process. The results also provide a comprehensive understanding of the antecedent variables impacting on consumer performance and normative participation.

Keywords Customer normative behavior • Customer participation • Customer performance • Interpersonal skills

1 Introduction

In general, service is understood as customer experience, which is aggregation of interaction with service organization from customer entering into service system to getting away it. This experience will be effected by each action of staffs

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(Susskind et al. 2007) and evolve the satisfied or unsatisfied service assessment at last. More and more service enterprises promote the interaction between staffs and customers to the organizational strategy layer, look it as a strategic weapon which can help them to gain competitive advantage (Solnet 2007), emprise the strengthening management on emotion, attitude and behavior of staffs in the service delivery. But service procedure can't formed without the customers and staffs together, service quality is not determined unilaterally, so the total control of service quality is difficult to realize only by strict staffs management.

Previous studies have shown that the consumer misconduct during service procedure, such as shoplifting and fraud, destroying service facilities, unjustified complaint, and so on, not only resulted in reducing service productivity (Yao and Wei 2013), damaging the consumption experience of the other consumers (Huang 2008), but also caused psychological distress to the front-line servers, even led them to emotional exhaustion (Xie et al. 2011). In order to standardize consumer behavior, some scholars proposed that some organizational measures should be adopted, such as setting up service place slogans (Berry and Seiders 2008), educating customers (Huang and Zhou 2012), designing and laying service situation (Grandey et al. 2004), supplying discriminate treatments to different customers (Harris and Reynolds 2009), designing and laying service situation (Ma et al. 2009), and so on. But these measures restrain differently individual behavior by outer forces, any careless will lead to customer dissatisfaction. And yet the study about the difference to different customers with individual characteristics is still lack. It leads to the comprehension of interaction between staffs and customers is focusing too much on enterprises and staffs, ignoring the important role of customers' individual behavior characteristics during the service quality control. As a result, there is lack of relevant theoretical basis which can provide personalized service strategic decision to each customer for enterprises.

This study inspects the effect of customer interpersonal skills on customer normative participation and customer performance (includes customer satisfaction and positive behavior post purchase), discusses the complicated relationships between these variables based on SEM. The conceptual model (as the Fig. 1 shows) and research hypothesis are as follows:

H_1: Customer interpersonal skills has positive impact on his normative participation.
H_2: Customer interpersonal skills has positive impact on service satisfaction.
H_3: Customer interpersonal skills has positive impact on his positive behavior post purchase.
H_4: Customer normative participation has positive impact on service satisfaction.
H_5: Customer normative participation has positive impact on his positive behavior post purchase.
H_6: Customer satisfaction has positive impact on his positive behavior post purchase.

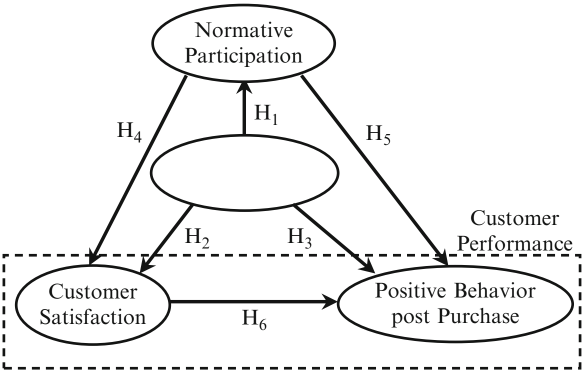

Fig. 1 Conceptual model

2 Research Design

Based on summarizing the existing research results, the questionnaire filled by respondents is designed. The questionnaire contents of each latent variable in theoretical model is as Fig. 1 shows:

2.1 *Interpersonal Skills*

Interpersonal skills are a kind of mental characteristics of individual which affects efficiency of interpersonal action and ensure a smooth interaction (Abouserie 1994). In the measurement, this research adopted the Interpersonal Interaction Ability Questionnaire which established by Buhrmester et al. (1988) has been broadly used in variously large study on social investigations. It includes five dimensions: initiate communication, provide emotional support, exert influence, openness and conflict resolution.

2.2 *Normative Participation*

At present, most studies describe customer participation from two angles: the behavior itself or the behavior result. For instance, some academics believe it is a kind of activity resources offered by customers in service production or transmission process, including mental, physical, and even emotional pay (Rodie and Kleine 2000), look it as a sort of cooperative production and co-creation (Payne et al. 2008). The others think it as not only the customer expression, but also their roles in service (Claycomb et al. 2001). These two definitions are no obvious mention on how customers take part in the service procedure, whether their actions conform to the social and enterprise standardized requirement, or how customers interact with staffs. Normative behavior often plays an important role in the interaction, it affects not only the forming of respective psychology contract, but also the cooperation and consequence. This study believes that the service group is composed of customers and staffs, the interaction between them conforms to the social and enterprise standardized requirement or not, determines the style of action that customers take part in the service production, pays more attention to the normative characteristics of customer participation.

This study refers to the Customer Participation Scale established by Peng Yanjun (2010), divides customer participation into four factors: preparation, information sharing, cooperative behavior and personal advice providing. In the item design, the social normality and positive attitude get more notice.

2.3 Customer Performance

Customer performance here is studied from two aspects: one is customers feeling of satisfaction or dissatisfaction for service, the other is positive behavior post purchase which can increase enterprise performance after customer leave service situation, for example, affording staff mistakes, oral spreading, repeating purchase, and so on.

1. *Customer satisfaction.* Currently the comprehensions about customer satisfaction in academia is various. Considering the connotation of this study, which defined by Anderson et al. (1994) is adopted: customer satisfaction is the overall evaluation on all purchasing experience of product and service, it is the degree of like or dislike after some consumption experiences and an overall attitude to accumulated experiences. It is evaluated separately by customer on his consumption experiences and consequences in the past one year or two.
2. *Positive behavior post purchase.* Customer behavior post purchase can be studied from various aspects. This paper analyzed it based on four factors which can increase enterprise performance: affording staff mistakes, repaying information of service perception, oral spreading, and repeat purchasing.

All of the above four latent variables are measured by Likert Scale, the range of values is “out of accordance” (1), “a little accordance” (2), “nearly accordance” (3) to “general accordance” (4), “absolute accordance” (5).

There also is some individual information of respondents in the questionnaire, such as age, gender, educational background, and so on.

Currently the comprehensions about customer satisfaction in academia is various. Considering the connotation of this study, which defined by Anderson et al. (1994) is adopted: customer satisfaction is the overall evaluation on all purchasing experience of product and service, it is the degree of like or dislike after some consumption experiences and an overall attitude to accumulated experiences. It is evaluated separately by customer on his consumption experiences and consequences in the past one year or two.

3 Date Collection and Analytical Tools Choice

After the questionnaire design had been completed initially, the first thing was issuance and recovery in a small range, then amended some items according to the emerging issues. Secondly, several semantic vagueness in the items were reaffirmed. At last, the items in the questionnaire were formally identified.

The investigation was conducted in Shenyang City from July to August in 2012. The researchers visited medium-sized restaurant, barbershop and hospital, randomly selected the customers who were waiting for service and willing to answer questions to take part in investigation. A small gift was given while the questionnaire was returned. One of the three cases was eliminated: the first was partial answer, the second was regular answer, such as all answers were 3 or the same number of 1,2,3,4,5 were alternately filled, the third was casual answer on account of the answers of the same question in different positions which had been deliberately predesigned were different. Finally, 248 effective questionnaires had been got and the effective rate of retrieve is 82.7 %.

The data statistics and analysis in this paper were completed with the Two-Phase Method by means of SPSS20.0 and AMOS7.0 software package.

4 Results of Statistical Analysis

4.1 Descriptive Statistics

The Table 1 shows the demographic feature of samples.

4.2 Reliability Test of the Model

According to the Two-Phase Method, the measurement model was validated and calibrated based on confirmatory factor analysis, each observed variable is associated with the corresponding latent variable, and the correlation between latent variables is allowed. The reliability of questionnaire was assessed by Cronbach α and composite reliability. Table 2 is the analysis result.

As Table 2 shows, each value of Cronbach α and composite reliability reaches the corresponding requirement. So the designed scale can be used to reliably measure the latent variables. And the standardized factor loading of each observed variable on the corresponding latent variable is from 0.72 to 0.91, and is significant at 0.01 level, accords with the requirement of convergent validity. Otherwise, the average variance extracted of each latent variable exceeds the lowest requirement of 0.5. It demonstrates the observed variables can explain most variance of latent variables. The discriminant validity of scale is tested by comparing the square root of AVE of

Table 1 Demographic feature of samples

Demographic variables	Variable values	Number	%
Gender	Male	112	45.2
	Female	136	54.8
Educational background	Middle school	3	1.2
	High school	13	5.2
	Junior college	28	11.3
	Undergraduate	122	49.2
	Postgraduate	74	29.8
	Doctor	8	3.2
Age	<20	20	8.1
	20–25	90	36.3
	26–30	82	33.1
	31–25	23	9.3
	36–40	8	3.2
	41–45	10	4.0
	>45	15	6.0

Table 2 Confirmatory factor analysis for measurement model

Variables	Factors	S.E.	Cronbach α	C.R.	A.V.E
Interpersonal skills	Initiate communication	0.85	0.920	0.921	0.702
	Emotional support	0.82			
	Influence	0.77			
	Openness	0.86			
	Conflict resolution	0.84			
Normative participation	Preparation	0.78	0.900	0.903	0.700
	Information sharing	0.77			
	Cooperative behavior	0.91			
	Personal advice providing	0.88			
Customer satisfaction	Process satisfaction	0.82	0.797	0.796	0.661
	Result satisfaction	0.81			
Positive behavior post purchase	Affording staff mistakes	0.77	0.854	0.856	0.598
	Repeatedly purchasing	0.82			
	Repaying information of service perception	0.72			
	Oral spreading	0.78			

each latent variable with correlation coefficient between latent variables. The result as Table 3 shows, the former is all higher than the latter, so the discriminant validity is acceptable. Therefore the reliability and validity of the designed measurement instrument is efficient.

Table 3 Checkout of discriminant validity analysis

Latent variables	Interpersonal skills	Normative participation	Customer satisfaction	Positive behavior post purchase
Interpersonal skills	**0.838**			
Normative participation	0.663	**0.837**		
Customer satisfaction	0.621	0.630	**0.813**	
Positive behavior post purchase	0.570	0.564	0.547	**0.773**

Note: The number in bold are the square root of AVE of each latent variable

Table 4 Test of structural model

Hypotheses	β	C.R.	Result
H_1: Interpersonal skills → Normative participation	0.663	9.538***	Support
H_2: Interpersonal skills → Customer satisfaction	0.363	4.094***	Support
H_3: Interpersonal skills → Positive behavior post purchase	0.266	2.901**	Support
H_4: Normative participation → Customer satisfaction	0.389	4.441***	Support
H_5: Normative participation → Positive behavior post purchase	0.244	2.604**	Support
H_6: Customer satisfaction → Positive behavior post purchase	0.229	2.323*	Support

Note: *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$

4.3 Test of Structural Model

After every index and parameter of measure model had met demand, the fitting of the structural model was tested by SEM, the concrete parameters were: $\chi^2 = 107.805$, $\mathrm{df} = 84$, $\chi^2/\mathrm{d}f = 1.283$, GFI = 0.944, CFI = 0.990, NFI = 0.957, RMSEA = 0.034. So it is advisable. The Table 4 is the test result and the Fig. 2 shows the estimated values of path coefficients between latent variables in SEM.

As Table 4 and Fig. 2 show, customer interpersonal skills significantly positively influences normative participation, positive behavior post purchase and customer satisfaction, so H_1, H_2, H_3 could been accepted, and the influence on normative participation is the biggest ($\beta = 0.663$, $t = 9.538$) among these.

Customer normative participation also positively influence his satisfaction, H_4 is acceptable. But the influence of normative participation is slightly obvious ($\beta = 0.389$, $t = 4.441$), that of interpersonal skills is relatively weaker ($\beta = 0.363$, $t = 4.094$).

Customer normative participation and satisfaction have positively impacts on behavior post purchase, H_5 and H_6 are all verified. But the effects of customer interpersonal skills, normative participation and satisfaction on positive behavior post purchase are not significant differences. Among these, the effect of normative participation is middle, is slightly lower than which of interpersonal skills and is slightly higher than which of satisfaction.

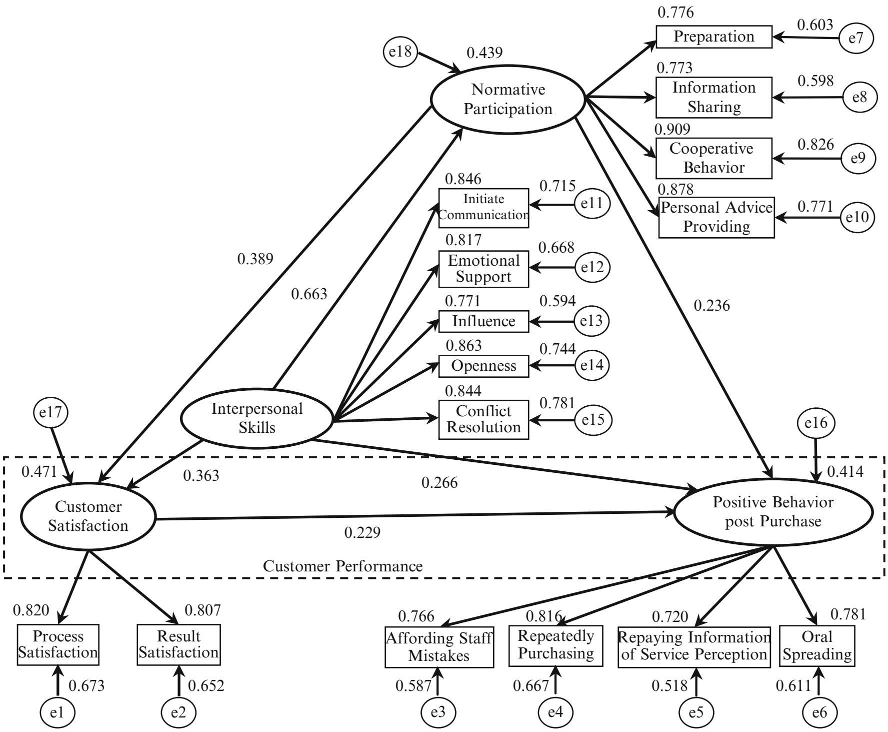

Fig. 2 Results of parameters estimates in SEM

5 Discussion

(a) Customer interpersonal skills has positive influence on customer participation in service production process, promotes customer taking more normative behavior to cooperate with servicers to complete the service process. This will be benefit of customer gaining more service satisfaction, and lead to more positive behavior post purchase in the future. All of these will bring greater competitive advantage to enterprises. It offers a new perspective to maintain service order and regulate customer except the traditional methods such as knowledge propaganda, placing environmental elements in service situation, etc. By testing the effect from customer interpersonal skills on customer performance, this research suggests that service enterprises take training measures to enhance customer initiative of normative participation by improving customer interpersonal skills in order to gain greater customer performance.

(b) Although different customer, different interpersonal skills, different participation method, will result in different satisfaction on same service, but normative participation play more role in customer satisfaction. So service enterprise should normalize customer participation by designing rational production process to mostly increase service satisfaction, no long be confined by traditional marketing concept about "the customer is God", "the customer is always right", etc.

(c) How prompts customer take positive behavior post purchase is the precondition of service enterprise gaining competitive advantage, so it is always the greatest focus. This study shows that customer positive behavior post purchase is positively affected by customer interpersonal skills, satisfaction and standard degree of participation. So service enterprise should give these front-line employees more autonomy in service process, allow them standardize participation behavior of customer who has different personality characteristics by different means. For example, the service process is mainly self-fulfilled by customer with strong interpersonal skills, what employees do is communication and auxiliary. But to the customer with weak interpersonal skills, most of process should be completed by employees in guiding ways. It cannot only ensure the appropriate participation, but also achieve more customer satisfaction.

6 Conclusion and Future Research Prospects

6.1 Conclusion

This research inspects the effect of customer interpersonal skills on customer normative participation and customer performance (include customer satisfaction and positive behavior post purchase) by the method of demonstration, and discusses the complicated relationships between these variables based on SEM. The results proves that the customer interpersonal skills has great effect on customer normative participation, satisfaction and positive behavior post purchase, reveals that during the process of customer consumes the service products, the influence of his interpersonal skills on behavior decision and the finally service experience, and provides a more comprehensive understanding to the antecedent variables which impact on consumer performance and normative participation.

This study provides a new perspective to manage customer behavior, suggests service enterprises pay more attention to the effect from customer psychological characters on his behavior, take measures to upgrade customer interpersonal skills, coordinate his communication with staffs and the other customers in service situation to avoid confusion, normalize customer participation, and finally win more customer performance.

6.2 Future Research Prospects

It can't be denied that there are some inadequacies of this study. Firstly, the scope of the investigation is limited to Shenyang City, it reduces the universality of the study.

In later work, it should be considered to sampling survey in different geographical regions so as to ensure the external effect. Secondly, this study only required respondents to evaluate the total feeling of various service accepted in the past two years, included both the lower participation service (like hairdressing, catering, i.e.) and the higher participation service (such as education, training, medical treatment, and so on). In the different types of services, the effects of normative participation on service quality and customer performance are different. In subsequent research, the appropriate research design should be taken according to different types of service enterprises to further study the effect of customer interpersonal skills on normative participation, satisfaction and positive behavior post purchase.

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Enterprise Customer Relationship Management Function Design and Business Solution

Xuan Luo

Abstract Description of the customer relationship management thought, proposed the establishment of "take the customer as the center" operation mode. The design of the function module of CRM, research and analysis of the marketing, sales management, service management the three most basic function modules, and put forward the corresponding business solutions. Through the construction of the customer relationship management, a new management mechanism can be established for improving the relationship between enterprise and customer.

Keywords Business solutions • Customer relationship management • Marketing module • Sales module • Service module

1 Introduction

CRM is Customer Relationship Management abbreviation, it is a collection of the most new information technologies, including Internet and e-commerce, multimedia technology, data warehouse and data mining, expert systems and artificial intelligence, call center and so on. CRM is application software; it embodies the marketing management concept. It is an integrated IT technology, is a new mode of operation, it comes new business model to "take the customer as the center", is a kind of new management mechanism to improve the relationship between enterprise and customer (Rongqing He 2006). CRM is not just software. It is a comprehensive methodology, software and IT ability, business strategy. No matter what the industry of CRM, its basic function and operation, management of enterprises in the role is basically the same (Kostojohn et al. 2012).

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CRM's main management thought is the customer is one of the most important resources of enterprise development, for the overall management of the enterprise and the customer relations, further extension of the enterprise supply chain management (Zaiqiu Gu 2009). CRM is the core of customer value management, it divides customers value as the value, potential value and value model, through one to one marketing principles, meet the personalized needs of different customers, increase customer loyalty and retention, achieve sustainable contribution of customer value, thereby improving corporate profitability. Improve the ability of the enterprise and the customer contact at each stage, from the initial marketing to the subsequent sales and service support, provide open, personalized user friendly interface, based on the role of enterprise portal, accurately and efficiently help you increase sales, improve profitability, establish a market leadership position, so that customers, employees and shareholders satisfactory (Li Xiong and Yujin Li 2012).

2 CRM Function Module Design

CRM is a continuously strengthen the communication with the customer, the understanding of customer needs, and constantly on the products and services to improve and improve to meet customer's needs continuous process. It contains is the use of information technology (IT) implementation of integrated marketing to customers and Internet technology, is the implementation of enterprise marketing to the customer as the core of technology and management (Nongji Zhou 2009). The main functions of the system are: the function of marketing, sales management, service management, interaction center module (Zaiqiu Gu 2009; Yunlong Zhu et al. 2006; Zaiyun Liu 2010). The CRM function module diagram is shown in Fig. 1.

2.1 Marketing Management Function Module

The marketing function can make the marketing plan, execution and evaluation to reach a new level of science and technology. Professional marketing in the enterprise

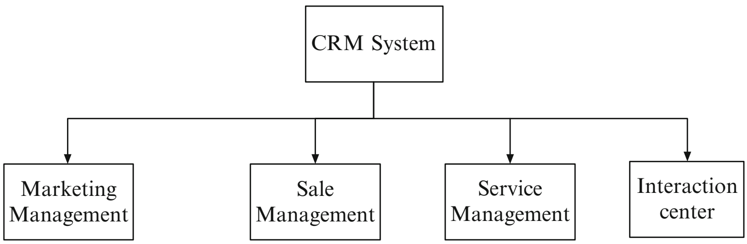

Fig. 1 The CRM function module diagram

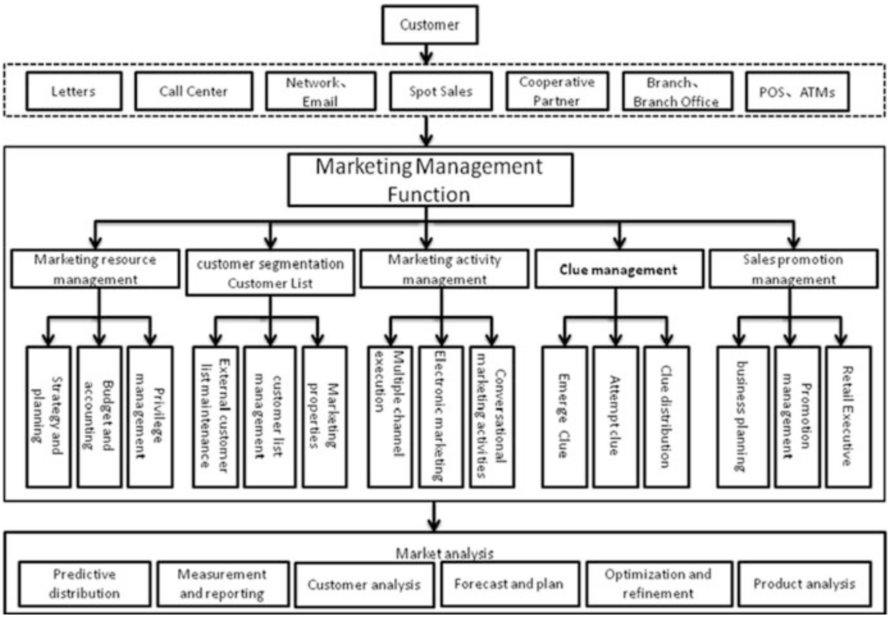

Fig. 2 The marketing function module

internal and external information resources center, can control the cost expenditure, verification, monitoring the market and competitor, planning successful action, coordination, management promotion customer life cycle, mobile office, to help you sell products and services.

Marketing module includes marketing resource management, customer segmentation and customer list management, marketing, clue management and marketing management (Yunlong Zhu et al. 2006; Zaiyun Liu 2010; Hu Chen and Fan Zhang 2010). Marketing resource management can enhance the management and optimization of internal and external marketing resources used functions (including budget, personnel, time and activities, etc.). Customer segmentation and list management is based on the properties of various customers, extraction from various data sources (such as: ERP external data), you can create a targeted marketing campaigns. Marketing management can be successfully contact with customers, to guide their demand for products and services. From the analysis, planning, development, implementation to evaluation, related to the management of the whole process of marketing activities in all interactions in the channel. Clue management is seamless integration between the sales and marketing department, to create high quality sales leads and track every clue to results. Increase sales leads to conversion rate and speed up the trail running period. Marketing analysis can transform data into information, help marketing department analysis of customer behavior, optimization proposal, accurate target customers and monitor marketing activities.

The specific function of marketing module is shown in Fig. 2.

2.2 Sales Function Module

Sales is the main part of the customer relationship management system, including the potential customers, clients, contacts, business opportunities, order, payment etc.. The salesman by recording the content of communication, establishing the schedule, query appointment reminder, fast browsing customer data effectively shorten the working time, and the large business reminder, sales funnel analysis, performance indicators statistics, business division and other functions can improve the entire firm into a single rate, shorten the sales cycle effectively help the managers, in order to achieve growth the greatest benefit business.

Sales function module mainly includes the plan, target, evaluation, implementation, measurement of these function modules (Yunlong Zhu et al. 2006; Zaiyun Liu 2010; Hu Chen and Fan Zhang 2010). The function module of the sales plan and forecast can provide income expectations and the quality of the production of the complete blueprint to ensure the accuracy of demand planning and forecasting, so as to build a complete view of a future possible income. The customer management can provide customers with 360 degrees omnibearing view, to ensure that everyone has the information is the same. Organizations can be important information, supervision, storage and tracking of all customers, potential customers and partners. The access plan and two-way synchronization function to support the use of activity management solution in advanced groupware scheme, can stick out a mile on all sales activities, promote teamwork, and enhance the efficiency of team. In the evaluation of business management more effective and predictable management sales cycle, can stick out a mile to enhance communication between business pipeline, team, and clues to the most appropriate arrangement of sales representative. Price management and obtain orders generate accurate quotations and product configuration, delivery orders, the availability of real-time validation of products and track order status. Sales contract management throughout the sales cycle, different sales channels and customers to implement the corresponding pricing strategy, ensure the most up-to-date personalized pricing information, with contracts and agreements. Sales analysis of real-time monitoring and response to customer need, accurate prediction, maintain a low budget, optimize the allocation of resources, and reasonable arrangements for the team to achieve revenue targets.

The specific function of sales module is shown in Fig. 3.

2.3 Marketing Management Function Module

Customer service is mainly used to fast and timely obtain customer information and customer history records, it can be targeted and efficient for customers to solve problems, improve customer satisfaction, enhance corporate image (Scott 2006).

Service module includes the service order management, contract management, complaints and feedback management, case management and quality management.

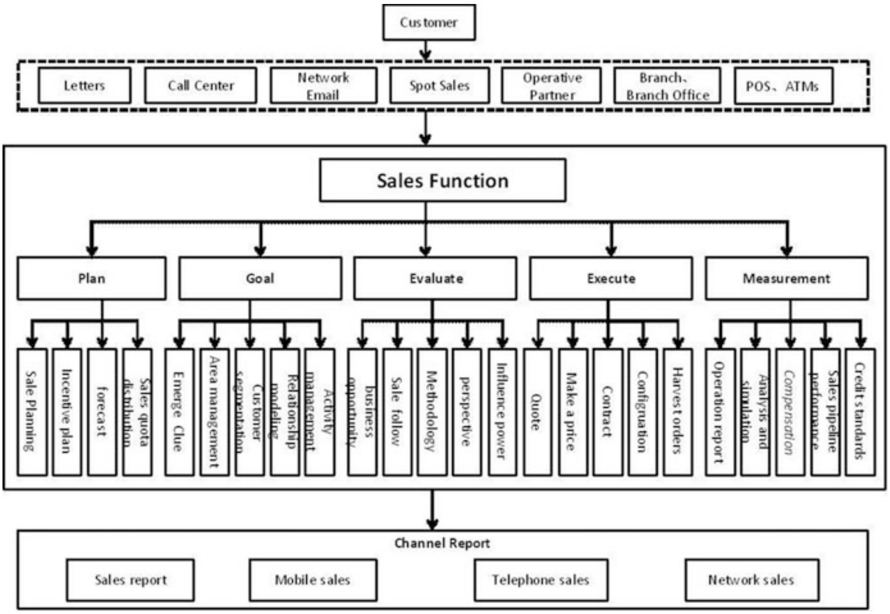

Fig. 3 Sales module

Service planning and forecasting can provide the ability to build a service plan, through preventive maintenance to ensure the product's excellent performance, and create a stable income flow for service.

Contract management is the handling of customer contract records and details, can meet the Department's monitoring to improve the quality of improving product quality requirements. Service management makes the customer service representative and field service personnel to take orders for product and service and check the availability and pricing of products and services. Service analysis can continuously improve the quality of services through evaluation of profitability, response ability, satisfaction, product reliability and cost, and control costs by monitoring the service charges. The specific function of the service module is shown in Fig. 4.

3 CRM Business Solutions

Companies need an immediate and all the existing business process integration solution, its powerful functions can be quick links and the whole information system for your business, at the same time, it has rich experience in the industry is the most solid support (Zaiyun Liu 2010; Mingliang Chen 2004).

CRM will take the customer as the center of the business (such as, marketing, sales and service) and the main internal enterprise (such as, logistics, financial)

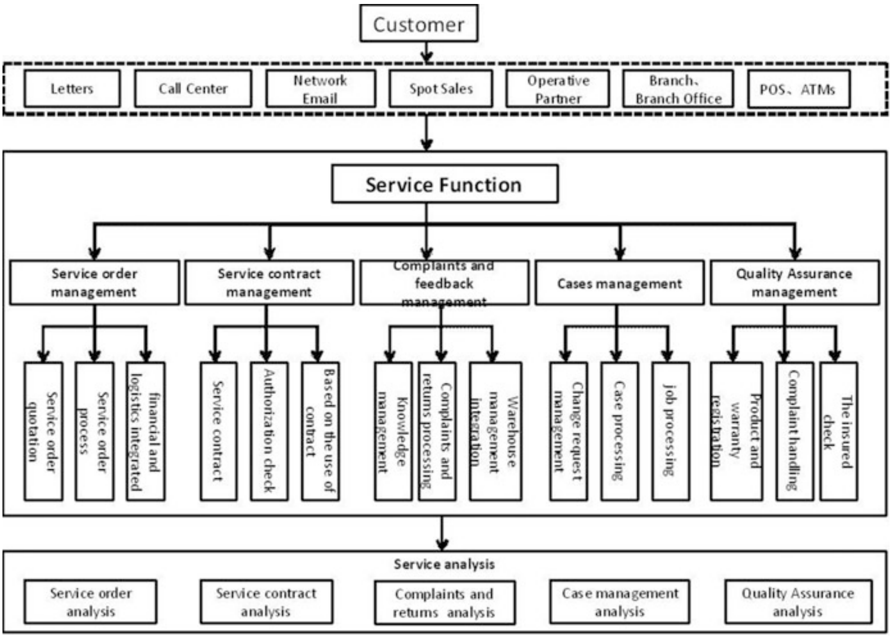

Fig. 4 Service module

Fig. 5 Business solutions

combined, can put the CRM into a new area, and proposed has the advantage of taking the customer as the center solution. Business solution is shown in Fig. 5.

Marketing solutions can make professional marketing in the enterprise internal and external information resources centre, can control the cost expenditure, verification, monitoring the market and competitor, planning successful action, coordination, management promotion customer life cycle, mobile office, to help you sell products and services, so the marketing planning, implementation and evaluation to reach a new level of science and technology.

Sales management solutions can be fully integrated with production, inventory, sales, service and financial system of the enterprise. Make sales plan and sales forecast mechanism can accurately, quickly analyze sales opportunities, effective management tasks. To cross sell as the goal, to promote the sales team in the sales environment of cooperation, provide strong support for every link in the selling process.

All aspects of the service order processing service organization in the service management solutions, from the initial inquiry respond to customer, create a quotation and quotation, create service order and assigned to the appropriate service representative, to the service representative has to perform the work and making confirmation to the customer billing. Help enterprises to provide the best service for all customers, ensure the long-term customer relationships and healthy development, and ensure the benefit of both.

4 Conclusion

CRM has been involved in more and more areas of science and technology, including computer, network, communication, multimedia, database, management and graphics etc. Its function is needed with the development of the industry and constantly improves. At present, many enterprises have already from “product center” to “take the customer center” transformation. So as to be able to present the enterprises pay more attention to the solution of CRM will be more and more.

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Part VII
Management Sciences – Financial Management

A Study on the Environment Quality Cost Control Model of Enterprises

Shu-ying Jin, Jing-jing Du, and Ying-wen Xu

Abstract Environmental cost control which directly influences the success or failure of environmental cost management is key to the environmental cost management for the enterprise. This paper is trying to research the change relationship between environment total cost and the level of pollution controlling based on many scholars' academic achievements. The research result which is drew by the quantified and modeled studying can further enrich the environment cost management theory and improve the environmental cost controlling effect.

Keywords Internal control information • Market effect • Mercerization degree • Voluntary disclosure

1 Introduction

Since the reform and opening, the economic development of our country has achieved remarkable results, however, in economic development and at the same time enterprise often expense the cost of the environment chasing profits, in production and management form a kind "first pollution, after management" and "real pollution, virtual management" vicious cycle. The cost of the environment is huge, the environment is more and more serious, runaway state economic development and the environment and resources, has become increasingly prominent

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contradiction between restricting our economic and social sustainable development of important factors (Ju 2011). At the same time, along with the social public attention to environmental issues, and the government's increasingly high degree of environment control increasingly strengthen, the enterprise bear environment pressure are also increasing (Zhang et al. 2005). Therefore, the enterprise environment cost control, and strengthened enterprise's environmental cost management, already can rich environment cost theory, and for the enterprise's management to provide valuable basis for decision-making.

Our country enterprise environmental costs (Zhen 2011; Yang et al. 2000) and environment of the cost control of studies have been conducted for several years, many domestic scholars also puts forward very typical view. At present Wang and Zhao (2002) etc. of environmental cost enterprises after processing present situation, foreign related research, combining mill ford corporation cases introduces foreign popular advance planning; Liuna puts forward can pass pre-need planning, course control and subsequent processing three process implementation the environmental cost of enterprise management; Zhang jie from environmental quality cost as the Angle of total quality management ideas for reference, established the environmental quality cost model, and this model from the recognition and environmental cost accounting, reporting and control etc., and put forward a set of environmental quality cost model based on the enterprise environment cost management methods, for enterprise environmental cost management reference; XuJiu equality in the analysis of the characteristics and environmental cost control, this paper puts forward mechanism based on the reality of environment cost two levels, leading to control mode, advanced control model in detail, and the case analysis; ChenLiang use system dynamics method research enterprise environment cost control strategy of environmental control cost investment, optimize the timing issue, to control pollution discharge and environmental loss cost mode and realization environmental effect and economic benefit of a win-win situation. According to the beforehand control, course control and afterwards environment cost control strategy of evolution analysis under, the results showed that the enterprise should choose to advance environmental cost control strategy.

At present domestic scholars to environment cost control research go through an engaged in control, after the development of the beforehand control. Due to the environmental prevent detection costs and environmental cost this up there in the relationship than volts, environmental cost control field, everybody is widely recognized by the enterprise exists an optimal control level, at this level, can realize environmental costs and the best economic benefit. This paper quality cost control concept, through the introduction of six sigma management establish enterprise dynamic environment quality cost control model, through the continuous evolution, think model to strengthen enterprise environment cost control can realize enterprise environmental costs and economic benefit of optimal.

2 Environmental Quality Cost

2.1 The Definition of Environmental Quality Cost

The definition of environment cost has a lot of kinds, this paper adopts and environmental quality cost control model consistent definition. In the comprehensive environmental quality management (TQEM) (Gao 2010), and on the basis of overall quality management in zero defect target, will enterprise pollution to the environment and damage as environmental quality defects, through the continuous improvement of environmental quality, in order to reduce or eliminate the environmental quality defects, thus to reduce the enterprise environment cost process. The ideal state is TQEM of "environmental damage", destruction of zero caused environmental quality can be defined as the direct deterioration, such as solid, liquid or gaseous remains emissions into the environment, or indirect degradation such as needlessly consumed raw material and energy. Therefore, environmental costs can be called environmental quality cost. As with quality cost, environmental costs is due to poor quality of existing environment of poor or may have the cost of environmental quality and happen. Therefore, environmental costs and cause deterioration of the environment, monitoring, control and prevent environmental degradation related.

The environment of enterprise cost management is associated environmental costs organized, planned predicted, decision-making, control, accounting, analysis and assessment waiting for a sequence of scientific management work. Its core is through the control of science will be reduced to the minimum level of environment cost, in order to realize the economic benefit of enterprise, social and environmental benefits is harmonious and unified. Environmental cost control is in ensuring environmental benefits and economic benefits, by taking the premise of a series of measures to control the environment pollution emission, business enterprise so as to reduce the environmental cost of enterprises, so as to realize the environmental cost minimization.

2.2 The Classification of Environmental Quality Cost

Environmental quality cost control model of total quality management ideas for reference, the classification of quality cost from the Angle of environmental quality cost control enterprise environmental quality cost will be divided into the following categories (Chen and Peng 2009):

Environment prevention cost: environment prevention cost is that enterprise in the process of production in order to prevent pollution and ecological environment undermine the role of the waste production cost and happen. Including enterprise environmental management organization and personnel's expenditure and other environmental management costs, and environmental protection education expenses, etc.

Environmental testing cost: environment detects the cost is to show enterprise to test the product, production processes or discharge waste etc. whether accord with a country related environmental protection laws and regulations and produces cost. Mainly includes enterprise in order to products, production processes or discharge of waste on environmental protection to detect and buy equipment, instruments and related expenses such as artificial cost.

Environment internal loss cost: environment internal loss cost is because the enterprise's production and business operation activities to cause damage to the environment, and the influence of these damages or enterprise through influence on governance, namely the spending occurred by enterprises themselves burden environmental costs. This part of the environmental costs include blowdown; Enterprise because of "three wastes" emissions cause damage to farmland, air pollution and destroyed crops, to residents of the surrounding compensation expenses, etc.

Environmental external loss cost: environmental external loss cost is because the enterprise's production and business operation activities to cause damage to the environment and the influence, but of these firms have not damage or influence on governance, but will these damage or influence by the enterprise other than pushing the environmental costs of main body to burden. This part of the environmental costs include resources occupation cost and ecological environmental damage cost (Chen 2008).

From the nature of environmental quality cost, we can see that these four types of environmental quality cost is divided into two categories: environment for cost control and environmental loss cost. Environmental control cost is to show enterprise to prevent its production and business operation activities on the ecological environment adversely affect the cost and happen, it includes environment prevent costs and environmental testing cost. Environmental loss cost is to show enterprise's production and business operation activities of the ecological environment has produced adverse effect, enterprise or business the subject to step outside the adverse effects and occurrence or are about to take place after costs, he include environmental internal and external loss cost. Environmental control costs and environmental cost to a certain extent, between the reciprocal relationship. For instance the enterprise of prevention and early detection work environment, to strengthen the environmental cost control enterprise's environmental increased, and meanwhile enterprise pollution in a little, and the internal and external environment cost is facing is also reduced.

3 Environmental Quality Cost Control Model

Use Y (x) says the enterprise environment total cost, C (x) says environmental loss cost function, use A (x) says environmental control cost function for the enterprise, including the x environmental pollution control level, then:

$$Y(x) = C(x) + A(x) \tag{1}$$

Use $\lambda = 1 - p$ says the x, obviously, environment pollution is the higher level of control. When $\lambda \to 1$, enterprise's pollution to the environment is the smallest, environmental pollution control level is the highest. So (1) can be expressed as:

$$Y\,(\lambda) = C\,(\lambda) + A\,(\lambda)$$

Among them, C (λ), considering the enterprise put in environmental protection costs and environmental testing cost two resources to obtain pollution control level lambda, so it can be used for the cobb-dauglas production function to say – loss cost C (lambda enterprises) and environment pollution control level, namely: the relationship status

$$C\,(\lambda) = \alpha_1 \lambda^{-\beta_1};$$

A (λ) is the environment control cost function, its size and pollution control level lambda relationship can be expressed as:

$$A\,(\lambda) = \alpha_2 \lambda^{\beta_2}$$

So the total environment cost:

$$Y\,(\lambda) = \alpha_1 \lambda^{-\beta_1} + \alpha_2 \lambda^{\beta_2} \tag{2}$$

$$\alpha_1, \alpha_2, \beta_1, \beta_2 > 0.$$

In order to solve the minimum of the total environment cost, Make (2) type derivative zero, namely:

$$\frac{dY\,(\lambda)}{d\lambda} = -\alpha_1 \beta_1 \lambda^{-\beta_1} + \alpha_2 \beta_2 \lambda^{\beta_2 - 1} = 0 \tag{3}$$

Solution:

$$\lambda^* = \left[\frac{\alpha_1 \beta_1}{\alpha_2 \beta_2}\right]^{\frac{1}{\beta_1 + \beta_2}} \tag{4}$$

λ* namely for the most appropriate environmental pollution control level, the corresponding Y(λ*) for environment of the total cost of the minimum value, thus λ* also called the most economic pollution control level. According to the enterprise environment cost curve equation, the environmental cost characteristic curve can describe as follows (Quality Management Science Club in Shanghai 2003):

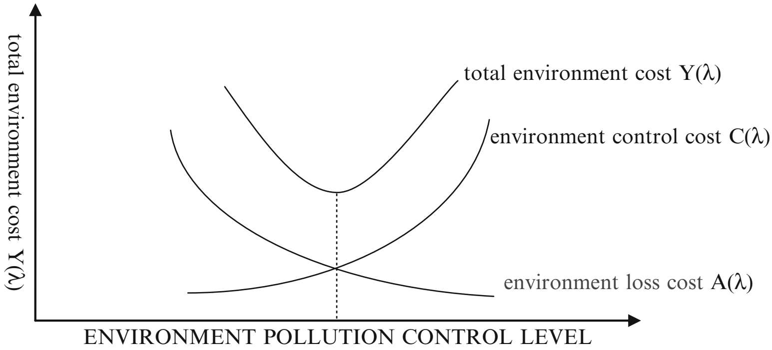

Fig. 1 Environmental control cost and environmental loss cost relationship chart

From Fig. 1 we can see, enterprise should its environmental cost control in λ^* nearby, when lambda in λ^* left, namely enterprise pollution control cost less than environmental cost, the enterprise pollution control levels return not enough, then enterprise should increase the environmental cost control, such enterprise environment can get lower cost, not only does not increase the enterprise environment total cost of environmental loss due to lower the cost of environmental control cost more than increase, so the environment will reduce the total cost instead. When lambda in λ^* right, to do the opposite of processing. Meanwhile, based on the environmental cost management model theory is that, should by constructing the enterprise environment cost accounting system for environmental cost control provide effective data as the basis for the control of environment cost; Enterprise should also set up environmental management organization, the agency not only responsible for buying environmental protection equipment, management waste recycling utilization etc. Work, more important is to keep the environmental cost of enterprise, and once found monitor its environmental cost deviation should be bigger, given instancing λ^*, take timely measures to ensure the environmental cost in λ^* nearby.

Meanwhile, based on the environmental cost management model theory is that, should by constructing the enterprise environment cost accounting system for environmental cost control provide effective data as the basis for the control of environment cost; Enterprise should also set up environmental management organization, the agency not only responsible for buying environmental protection equipment, management waste recycling utilization etc. Work, more important is to keep the environmental cost of enterprise, and once found monitor its environmental cost deviation should be bigger, given instancing λ^*, take timely measures to ensure the environmental cost in λ^* nearby. And this model is in statistical average state, eliminating accidental element, random factors, through the statistics for a period of time after the environmental cost data of applied economics metrology method to find the change rule of environmental quality cost, establish the change rule of the mathematical model, the establishment of more scientific, ideal minimum environment total costs and optimal pollution control level (Qu 2007).

4 Conclusions

This article discussed on the environment quality cost control model. And draw the optimal environment control level and minimum environmental costs. But this model research is still in the theoretical exploration stage, and pending further verification and inspection practice is necessary.

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The Impact of Different Rankings of Large Shareholders to the Rate of Return

Jian Su and Xiao-ming Ji

Abstract 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 *ROA* (Return on Assets) could be regressed on Z (the radio of large shareholders) and L, I, F (the dummy variables of different large shareholders). By the empirical result, the dummy variable of institutional investors in any ranking is always positive related to ROA. The dummy variable of legal investors is negatively related to ROA at 1 % significant level only when they are the largest shareholders. In the other rankings, legal shareholders have no significant impacts on ROA. As the largest shareholders, the foreign investors' dummy variable is positively related to ROA. When the foreign investors are the second largest shareholders, their dummy variable has not impacts on ROA.

Keywords Corporate governance • Institutional investor • Ownership structure • Power's balance

1 Introduction

The ownership structure theory explains how to realize the maximum value of the company, which is a balance of shareholders' power. Since different shareholders have their own investment motivation, it is very difficult for all the shareholders to become an alliance of the same interest. For example, large shareholders

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prefer long-term profits; while small shareholders always like their investments be back in the shortest time. The large shareholders investment motivations vary as their different background. McConnell and Servaes (1990) proved that internal shareholders could not always reach a consensus. For example, when a son received the inheritance from his father, or a shareholder his stocks, those new shareholders may become the block shareholders (McConnell and Servaes 1990). Shleifer and Vishny (1986) believed the small shareholders cannot play any power's game with large shareholders, since they were too weak and always kept the arbitrage motive, so most power's games are played by several large shareholders. For a company, the major shareholders' game is more important than others' (Shleifer and Vishny 1986). Therefore we will study the relationship between power's game and the top three shareholders by the empirical research.

This paper investigates whether and how the different large holders' power of equity can affect the performance of Japanese listed companies. With sample data of companies listed on Tokyo Stock Exchange, it was interpreted that *ROA* (Return on Assets) could be regressed on the radio of large shareholders and the dummy variables of large shareholders of different background in a different ranking.

2 Power Balance Theories

Zwiebel (1995) considered that the power balance of equity to be the following three forms: the first one is constituted by one overwhelming shareholder and many small shareholders; the second one is constituted by many small shareholders; and the third one is constituted by several larger shareholders (Zwiebel 1995). Gomes and Novaes (2005) firstly discussed the behaviors of the largest shareholders and the larger shareholders groups, and 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 (Gomes and Novaes 2005). Equity effect refers to the internalization of the enterprises' value when shareholders transferred their share and control rights. The compromise effect refers to the negotiation among larger shareholders. Pagano and Rell (1998) believed that while the developing enterprises need the support of funding, the original shareholders would worry about their right of control will 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 Rell also believed that if outside shareholders kept large amount of shares, they will be hostile to the original shareholders. Bennedsen and Wolfenzon (2000) suggested the equity power balances system was decided by the alignment effects and formation effects of a number of large shareholders (Bennedsen and Wolfenzon 2000). The alignment effects were the production of many large shareholders' collusion. This collective conspiracy was more efficient than the single largest shareholders. The high shareholding ratio can reduce the agency costs and increase the company value.

Different from the theoretical research, we didn't 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 (Short and Keasey 1999). But Paolo (2000) suggest that the second largest shareholder could promote the performance of listed companies in Germany (Paolo 2002). 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 (Luc and Levine 2004).

3 The Model and Variables

In order to verify how the large shareholders' power can influence traditional corporate governance, we will use the fixed effect model to analyses 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 1,860 samples totally. We will try to find how the large shareholder of different background in a different ranking affect the operation efficiency by testing the relationship between the corporate performance and dummy variables of large shareholders' background in different ranking. Since there are no connections between the shareholders' background and the corporate governance, this if we could find this relationship, it will be proved that shareholders' different background in different ranking can affect the company policy (Su 2010).

By the observation, there are five kinds of large shareholder in Japanese list companies that include legal shareholders, inside shareholders, natural person shareholders, institutional shareholders and foreign shareholders. We will select institutional shareholders, the foreign shareholders and legal shareholders being the research object.

3.1 The Model

In order to prove how the shareholders' power could affect the performance, we chose ROA and to be the dependent variable. Z, L, I, F, the independent variables are shareholding ratio of the largest shareholders and dummy variables of institutional shareholders, foreign shareholders and legal shareholders. In the actual verification process, the largest shareholding ratio (Z) will be replaced respectively by the shareholding ratio of the first three largest shareholders(Z1, Z2 and Z3); dummy variables will be replaced respectively by large shareholders of three kinds of background of first three large shareholders (L1, L2 and L3, I1, I2 and I3, F1, F2, and F3). Demzetz 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 model, we will add the control variables (Demsetz and Lehn 1985). In summary, our model is as follow:

$$ROA_{it} = Intercept + Control\ variables_{it} + \gamma Z_{it} + \beta_1 L_{it} + \beta_2 I_{it} + \beta_3 F_{it} + \varepsilon_{it}$$
$$\varepsilon_{it} = \theta_t + \omega_{it}$$
$$i = 1, 2, \ldots, N \quad t = 1, 2, \ldots, T$$

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 $N(0,\sigma^2)$.

3.2 Variables

As the dependent variable, ROA can show not only the profit of the shareholders, but the performance of the liabilities, which can fully reflect the governance efficiency. Investors have different motivations (Linderberg and Ross 1981). 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 (Tobin 1969). Therefore, the independent variables are the radio of the three largest shareholders (*Z1*, *Z2* and *Z3*) and dummy variables will be replaced respectively by large shareholders of three kinds of background of first three large shareholders (*L1*, *L2* and *L3*, *I1*, *I2* and *I3*, *F1*, *F2*, and *F3*).

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 (Perfect and Wiles 1994). Control variables include the asset-liability ratio (*D/A*), the logarithmic of the stock market price ($log_{10}V$) and the logarithmic of intangible assets ($log_{10}IA$) (Jian and Xiaoming 2012).

Table 1 Statistical description

	ROA	$log_{10}V$	*D/A*	$log_{10}IA$	Z1	Z2	Z3
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

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). We collected totally 1,860 samples from 620 enterprises in 3 years, except data of financial firms and public utilities' firms, as well as part of the incomplete data. Table 1 is the statistical description, while Table 2 is the verified results:

We can find from Table 2, all control variables are significant at the 1 % 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 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.

5 The Empirical Result Analysis

Although the cross-shareholding ratio is decreasing, most of the largest shareholders in Japanese capital market are still cross-shareholders (Jian Su 2011). That will lead to the rise of agency costs and the reduction of ROA. However, the rising of the second shareholding ration of the second largest shareholder can promote ROA, which shows it shows the second largest shareholder's impact on the largest shareholder. This power balance can reduce the agency costs through more public business polices. This result is also consistent with the theory of Lehman and Weigand (2000). Moreover, the results also proved that the founding of the power

Table 2 The relationship between ROA and the shareholding ratio

	1st	2nd	3rd
Intercept	−2.16	−1.93	−0.84
	(−25.61)	(−14.78)	(−5.35)
D/A	−0.10	−0.09	−0.04
	(−4.15)	(−4.51)	(−4.73)
$log_{10}V$	0.19	0.177	0.095
	(25.13)	(19.24)	(16.40)
$log_{10}IA$	0.20	0.16	0.08
	(9.15)	(9.93)	(9.18)
Z1	−0.70		
	(−4.76)		
Z2		1.13	
		(4.37)	
Z3			−2.41
			(−2.65)
L1	−0.19		
	(−4.64)		
I1	0.15		
	(2.66)		
F1	0.26		
	(4.60)		
L2		0.25	
		(1.10)	
I2		0.09	
		(2.21)	
F2		0.07	
		(0.88)	
L3			0.11
			(1.61)
I3			0.08
			(2.55)
F3			−0.11
			(−1.99)
R^2	0.86	0.79	0.67
F	15.64	14.85	14.09
$N \times T$	1,860	1,860	1,860

Note: **, * represents 1 and 5 % significantly. ( ) is T statistics

balance of equity in the enterprises could contribute to the development. The increasing of the third largest shareholding ratio will reduce ROA. In Japan, the average shareholding ratio of the third largest shareholders is 4.8 %, less than 5 %, the statutory largest shareholding ratio. That means the third largest shareholders cannot be called the real big shareholders. Therefore, the third largest shareholders could be inferred as the arbitrage investors, who prefer short-term operating policies, which won't improve the efficiency of corporate governance (Maury and Pajuste 2005).

We can find though the result of the empirical research of dummy variables, institutional shareholders, foreign shareholders and legal shareholders can control the company independently. It also shows the largest shareholders' domination of listed companies in Japan. Legal shareholders' dummy variable (*L1*) showed the 1 % significant negative relationship with ROA. Most of the largest shareholders are still cross-shareholders, whose investment objectives are improving the efficiency of themselves. They have not enough interests on the listed companies' performance (Jian Su 2010). This will lead to the rising of agency costs, and the significant decreasing of the business efficiency. The legal shareholders are important reasons of reducing the ROA. Dummy variables have positive relationship with ROA, when the largest shareholder (*I1*) is institutional investors or foreign investors (*F1*). It proves that institutional investors' and foreign investors' motivation is direct earning.

Among the second largest shareholders, institutional investors are the only ones remaining the significant positive effect on ROA, and the impact on corporate governance. As the second largest shareholders, legal investors and foreign investors' behaviors are not unified. When the legal shareholders are the second largest shareholders, their investment objectives are usually attached to the largest shareholders. Foreign investors cannot affect corporate governance because of the asymmetric information and the international market incompleteness (Blanchard et al. 1993).

No significant relationship between legal investors and the dummy variable (*L3*) or ROA could be found when they are the third largest shareholders. Then we believe their investment motives are always attached to the largest shareholders. No matter they are the second or the third largest shareholders. When institutional investors are the third largest shareholder, the positive relationship between the dummy variable (*I3*) and ROA is significant at 5 % level. It shows that institutional investors, as the third largest shareholders, still keep the impact on corporate governance. The dummy variable of foreign investors (*F3*) as the third largest shareholders is negatively related to ROA at 5 % significant level. Then those foreign shareholders' investment motivations are short-term and arbitrage.

6 Conclusion

This paper investigated whether and how large shareholders' power could affect the performance of Japanese listed companies. We used the fixed effect model to analyze 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 were 1,860 samples totally.

We found how the large shareholder of different background in a different ranking affect the operation efficiency by testing the relationship between the corporate performance and dummy variables of large shareholders' background in different ranking. By the empirical result, the dummy variable of institutional investors in any ranking is always positive related to ROA. The dummy variable of legal investors is negatively related to ROA at 1 % significant level only when they are the largest shareholders. In the other rankings, legal shareholders have no significant impacts on ROA. As the largest shareholders, the foreign investors' dummy variable is positively related to ROA. When the foreign investors are the second largest shareholders, their dummy variable has not impacts on ROA. When the foreign investors are the third largest shareholders, their dummy variable is negatively related to ROA. We believe that in any rankings from 1st to 3rd, only institutional investors can affect the corporate governance. Because of the invest objects, legal investors and foreign investors cannot always influence the corporate governance.

These results suggest that corporate governance could be more efficient, when the institutional shareholding ratio were increased. The foreign shareholders were the arbitrage investors, whose shareholding ratio was negatively related to ROA. Legal investors were a main group in the capital market, but their monopoly power should be restricted by law.

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Political Connections, Debt Financing and Firms' R&D Investment – Evidence from Listed Companies in China

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Abstract On the basis of listed company's date from 2009 to 2011, this paper empirically studies the influence political connections and debt financing have on firm's research and development investment. It is suggested that there is an inverse correlation between the ratio of debt financing (bank loans) and the research and development intensity. By occupying a large amount of short-term debts, firms fail to reverse the debt financing constraints, and the key still lies in the deficiency of support from long-term debt. Although political connections bring certain long-term debt resources to firms, they fail to generate significant "resource effect" and drive firms' research and development investment as expected. On the contrary, political connections also bring "extrusion effect", to which firms should pay enough attention and introspect themselves.

Keywords Debt financing • Debt maturity structure • Political connections • R&D investment

1 Introduction

Research and development (below with the representatives of R&D) is critical to innovation and economic growth. However, our enterprise has been the problem of lack of investment in R&D, and how to effectively deal with this issue increasingly urgent. With the emergence and development of information economics, the role of financial factors that impact on business investment has been universally recognized, and financing constraints caused people's attention. Scholars at home and abroad show that the R&D activities have faced more severe financing constraints especially

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have faced more external financing difficulties (Himmelberg and Peterson 1994; Hall 2002; Qun Gu and Shuping Qu 2011). Therefore, in the face of fierce international competition, it has a very important practical significance to explore ways to ease the external financing constraints to increase the firm's R&D investment.

Over the past three decades, Chinese financial market is featured as being transitional and innovative and gradually formed the bank-based financial systems. The development of the stock market is just starting, financing from the stock market, both in scale and importance, are in second place in the corporate external financing, debt financing so far is still the main source of external financing. So, the key to restricting corporate R&D investment in China is reflected in the debt financing constraints. Throughout the previous studies, we can find that the most of their researches are from the total amount of debt financing, that is to say they think different liabilities are homogeneous. But my paper explore the problem of debt financing constraints by parsing different maturity structure of the debt financing, and hope to solve the plight of debt financing of the R&D activities by deep-seated structural analysis of the debt financing. At the same time, any corporate investment behavior is affected by the impact of the institutional environment. Institutional environment affects the governance role of the debt and the maturity structure of debt. Today, the various systems are not sound and the government plays a dominant role in the economy, which make the political connections as an alternative mechanism of the market and the legal system increasingly play an important role in the socio-economic activities. Therefore, this paper introduces the political relations as dummy variables of the system background to study the different effects of debt maturity structure on R&D investment intensity.

Our study extends the literature about the corporate debt financing and R&D investment behavior. This article is the first to distinguish different debt financing structure – the maturity structure of debt financing to study the effects on corporate R&D investment intensity. In this paper, we link the research about the influence debt financing have on firm's R&D intensity with the institutional background of political connections, which not only helps to explain the internal mechanism that how the government influence corporate behavior, but also help us get policy recommendations derived from the reality of practical significance.

2 Theories Analysis and Research Hypothesis

2.1 Debt Financing and R&D Investment

Corporate debt financing has three main sources, namely bank loans, commercial credit and corporate bonds. However, corporate bonds have only a small proportion in the corporate bond financing liabilities of listed companies in China, and Fang Wen (2010) points out that commercial credit is difficult to become a source of funds of R&D investment, because the funds from commercial credit is more dispersed, smaller transaction amounts and basically making commercial credit creditor difficult to constraint the debtor. In the bank-based financial systems, commercial bank loans so far are still the main source of external financing. Therefore, the bank credit is the main sources of debt financing in the corporate R&D activities, which has an important impact on R&D investment. So the subject of our study is the impact of bank loans to corporate R&D intensity.

The modern Western literature to explain the theory of debt financing affect the corporate investment is mainly that the conflict of shareholders – creditors how to affect the corporate investment. In 1972, Fama and Miller first discussed the impact that shareholders – creditors conflict on corporate investment decisions. Their study showed that on the choice of investment projects, shareholders and creditors have conflicts of interest, because shareholders prefer projects with high income uncertainty but creditors prefer projects with low income uncertainty. Jensen and Meckling (1976a, b) developed the problem in the study of agency costs and concluded that the stockholder- creditor conflicts due to debt can lead to asset substitution and under-investment problem. The asset substitution problem means the shareholders loan funds to invest in a higher risk (relative to the project understood by the debtor to obtain loans to investment risk), so that the actual risk of the loan increases, thereby depriving the wealth of creditors and reducing the value of the loan liabilities. Myers (1977) defines the value of a firm as the sum of the value of its growth opportunities. If the cash flow relative to the reimbursement value, the shareholders will prefer not to undertake the investment. They will then be passing up a positive net present value opportunity at the expense of debt holders. It causes under-investment problem. In the light of these problems, debt holders will impound a premium in the required interest rates and unwilling to provide loans to high-risk enterprises. R&D investment is a risk, long cycle investment activities, exacerbated by asymmetric information and moral hazard, which provide more opportunities to managers and shareholders to implement such asset substitution and under-investment.

In the current economic environment, China's commercial banks under the premise of lack of credit resources and ensure the quality of credit assets, is bound to prefer low-risk, high-yield projects, resulting in high-risk corporate R&D activities lack of the support of bank loans. Fang Wen (2010) also proved that the bank loans have negative impact on R&D investment. Based on the above theoretical analysis, we propose the following hypotheses:

Hypothesis 1: R&D intensity is negatively related to bank loans.

2.2 Debt Maturity Structure and R&D Investment

Another important impact of the debt financing on corporate investment behavior is debt maturity structure. Pan Tong (2005) provided empirical evidence that different debt maturity structure will have different effects on corporate investment behavior. So there will have diversity in the degree of correlation between different debt maturity structure and R&D intensity. Brown and Petersen (2009) concludes that R&D activities face financing constraints, especially long-term debt financing constraints due to its features of the high-risk, high-information asymmetry, high growth and less available mortgage tangible assets. Bah and Dumontier (2001) point out that short-term loans can reduce asset substitution motivation and control the problem of under-investment, because Short-term loans to enable enterprises are often faced with the pressure of debt service, and the short-term borrowing requirements companies often re-signed debt covenants. And when the enterprises are facing bankruptcy, the short-term debt financing is more conducive to the creditor to recover the funds. Qianfu Huang and Hong-bo Shen (2009) support the idea that Short-term debt is more conducive to the protection of the interests of creditors. Therefore, when the R&D activities face financing difficulties, they can receive more support to obtain short-term debt.

In the current financial environment, the realistic risk prevention needs makes the bank to take the financing discriminatory policies, resulting to make the enterprise often get funds in the form of short-term loans (Jianwei Chen 2007). Meanwhile, a large part of short-term liabilities exist recycled, which makes the short-term loans play the role of long-term loans. And enterprise misappropriate short-term funds to invest in high-risk projects are also relatively common. Therefore, R&D-intensive firms may use more short-term loans relative to long-term loans to ease the debt financing constraints. Based on the above theoretical analysis, we propose the following hypotheses:

Hypothesis 2: The debt restraining effect on long-term loans of R&D intensity greater than the short-term loans.

2.3 Political Connections, Debt Financing and R&D Investment

Debt financing of corporate investment behavior is always subject to the constraints of the institutional environment. With our economy is in the process of transition, legal, financial and other systems are not perfect and the government still holds the allocation of rights related to the survival and development of resources, so that to establish connection with the government become the important institutional environment that debt financing affect R&D investment. A lot of research also proves that political connections exist in most Chinese firms (Fan et al. 2007; Wenfeng Wu et al. 2009).

Frye and Shleifer (1997) point out that established political connections between firms and government, manifested as a double-edged sword, that is to say the government may be a “helping hand” or may be a “grabbing hand”. Yawen Jiang et al. (2011) show that political connections on the firm’s innovation activities not only have “resource effect” but also have “extrusion effect”. At present, China has entered the era of the development of science and technology based on independent innovation. The government increases efforts to support the firm's R&D activities, and this support is mainly reflected in the tilt of the bank loans resources.

Long-term investment in R&D activities needs a lot of money, if lack of availability of funds will result in R&D activities to be interrupted and even be given up, so long-term debt is continuing to promote R&D activities. When R&D-intensive firms face debt financing constraints and need more long-term debt, the political connections is an important reputation mechanism to convey to the bank by a signal of government support and protection, to some extent, firms enjoy the implicit guarantee of the government and guarantee their credibility. Also the firm's with Government background conducive to reducing asymmetric information. Therefore, compared with the firms without political connections, firms with political connections can receive significant "resource effect" and may weaken the debt constraints to ease the conflict of the creditors (commercial banks) and shareholders, and may get more resources, especially long-term loans longer term loans to optimize the structure of the debt financing of R&D investment. Based on the above theoretical analysis, we propose the following hypotheses:

Hypothesis 3: Compared with the firms without political connections, firms with political connections can optimize debt maturity structure and ease the debt financing constraints.

3 Study Design

3.1 Sample Selection

This paper chooses companies which disclosed the 2009–2011 R&D expenditures in Shanghai and Shenzhen Stock Exchanges, Samples screened by the following principles: (1) Excluding the ST and PT companies each year; (2) Excluding the companies which lose financial indicators; (3) Excluding the companies without disclosure of R&D data. The screening sample consisted of 888 sample observations (296 listed companies), forming a balanced panel date,. R&D expenditures data come from the company's annual financial report and other financial data come from the CSMAR database.

3.2 Empirical Models

Previous studies have shown that many factors affect firm's investment, such as firm's cash flow (CF), firm's value (Tobin Q), and sales (S). Therefore, we introduce these variables in the model as control variables. According to the proposed hypotheses, in order to study the influence debt financing have on firm's R&D

intensity, we put forward the following models:

$$\mathrm{RDI}_{i,t} = \alpha_0 + \alpha_1\ \mathrm{LA}_{i.t-1} + \alpha_2\ \mathrm{CF/K}_{i,t} + \alpha_3\ \mathrm{Q}_{i.t} + \alpha_4\ \mathrm{S/K}_{i,t} + \varepsilon. \tag{1}$$

$$\mathrm{RDI}_{i,t} = \alpha_0 + \alpha_1\ \mathrm{LTD}_{i.t-1} + \alpha_2\ \mathrm{STD}_{i,t-1} + \alpha_3\ \mathrm{CF/K}_{i,t} + \alpha_4\ \mathrm{Q}_{i.t} + \alpha_5\ \mathrm{S/K}_{i,t} + \varepsilon \tag{2}$$

In order to test the influence debt financing have on firm's R&D intensity from the view of political connections, we put forward the following models:

$$\mathrm{RDI}_{i,t} = \beta_0 + \beta_1\ \mathrm{LA}_{i.t-1} + \beta_2\ \mathrm{LA}_{i.t-1} * \mathrm{Pol} + \beta_3\ \mathrm{CF/K}_{i,t} + \beta_4\ \mathrm{Q}_{i.t} + \beta_5\ \mathrm{S/K}_{i,t} + \varepsilon. \tag{3}$$

$$\mathrm{RDI}_{i,t} = \beta_0 + \beta_1\ \mathrm{LTD}_{i.t-1} + \beta_2\ \mathrm{LTD}_{i.t-1} * \mathrm{Pol} + \beta_3\ \mathrm{STD}_{i,t-1} + \beta_4\ \mathrm{STD}_{i.t-1} * \mathrm{Pol} + \beta_5\ \mathrm{CF/K}_{i,t} + \beta_6\ \mathrm{Q}_{i.t} + \beta_7\ \mathrm{S/K}_{i,t} + \varepsilon \tag{4}$$

In these models, RDI for R&D intensity, it equals to R&D expenditure divided by the total sales revenue; LA represents bank loans, which equals to the ratio of long-term loans plus short-term loans to total assets. LTD and STD represent debt structure. LTD equals to the ratio of long-term loans to total debt and STD equals to the ratio of short-term loans to total debt. One year of lagged date of debt financing variables are necessary, because the current investment decision-making is generally determined by the beginning of the period of the debt financing structure. We define political connections based on Minggui Yu and Hongbo Pan (2008). If one of the company's Chairman or general manager is a former or current government official, NPC deputy or CPPCC member, the Pol value to "1", otherwise the value is "0".

4 The Empirical Results and Analysis

4.1 Descriptive Statistical Analysis

Table 1 is the descriptive statistics of the main variables. As we can see from Table 1, the mean of R&D intensity is 3.73 % in the listed firms in China. It's generally considered that R&D intensity of enterprise accounted for 2 % of sales revenue can maintain the survival, and accounted for 5 % of sales revenue is competitive. The samples are listed firms and R&D activities are relatively frequent, so the overall of Chinese firms' R&D intensity will be lower. Relevant information shows that the U.S., Japan and Europe firms' R&D intensity of 4–8 %, so comparing

Table 1 Descriptive statistics

Variables	Minimum value	Maximum value	Mean value	Standard deviation
RDI	0.0000	0.8283	0.0373	0.04693
LA	0.0000	0.8050	0.1640	0.1389
LTD	0.0000	1.0000	0.1753	0.2579
STD	0.0000	1.0000	0.6884	0.3695
Pol	0.0000	1.0000	0.6756	0.4684
CF/K	−0.3004	0.3755	0.0539	0.0779
Q	0.7090	15.2990	2.5103	1.6238
S/K	0.0506	3.5169	0.7582	0.4499

Table 2 Regression results of debt financing and R&D intensity

Variables	Model (1)	Model (2)
Constant	0.58***(12.046)	0.062***(10.563)
LA	−0.68***(−5.986)	
LTD		−0.025***(−3.692)
STD		−0.022***(−4.419)
CF/K	0.025*(1.229)	0.022*(1.053)
Q	0.003***(5.883)	0.004***(3.965)
S/K	−0.22***(−6.539)	−0.021***(−5.853)
R^2	0.244	0.282
Adjust R^2	0.228	0.257
F value	15.625***	11.019***

Annotation: ***$p < 0.01$; *$p < 0.1$

with developed countries, we still has a big gap in the level of R&D investment. Therefore, Firms and government should continue to attach importance to science and technology innovation and increase R&D input and R&D efficiency. Also, we can see from Table 1, the firms with political connections have accounted for 67.57 % of the total sample. It suggests that firms in China with political connections have become relatively common phenomenon. The mean value of LA is only 16.40 %, it shows that the listed firms in China get little bank loans to increase R&D input and it is closely to the bank of taking the policy of credit crunch. Furthermore, the average long-term debt ratio is 17.53 % and short-term debt ratio is 68.84 %, indicating that the sources of debt financing of listed companies mainly rely on short-term loans, not the support of long-term loans. Whether short-term loans can reverse the debt financing constraints of R&D investment still need further research.

4.2 *Empirical Result Analysis*

In Table 2, the results of Model (1) show us that the regression coefficient between R&D intensity and LA (bank loans) is −0.68, and it passes the test of significant level of 1 %. It shows that R&D intensity is negatively related to bank loans. So

Table 3 Regression results of political connections, debt financing and R&D intensity

Variables	Model (3)	Model (4)
Constant	0.58***(12.043)	0.62***(10.184)
LA	−0.71***(−4.706)	
LA*Pol	0.005(0.352)	
LTD		−0.035***(−3.007)
LTD*Pol		0.013*(1.062)
STD		−0.019***(−3.471)
STD*Pol		−0.002(−0.479)
CF/K	0.025*(1.230)	0.022*(1.085)
Q	0.003***(3.316)	0.004***(4.402)
S/K	−0.22***(−6.526)	−0.020***(−5.851)
R^2	0.253	0.291
Adjust R^2	0.238	0.264
F value	16.325***	12.029***

Annotation: ***$p < 0.01$; *$p < 0.1$

hypothesis 1 has been proved. The results of Model (2) show that the absolute value of the regression coefficients of $LTD_{i,t-1}$ is greater than the absolute value of the regression coefficients of $STD_{i,t-1}$ ($|-0.025| > |-0.022|$), which is consistent with Hypothesis 2. It suggests that different debt maturity structure will have different effects on firm's R&D investment behavior. And debt restraining effects on the long-term loans of R&D intensity greater than the short-term loans. Also, we can conclude from the regression coefficient of $STD_{i,t-1}$ still less than zero that although they have a large amount of short-term debts, firms fail to reverse the debt financing constraints, and accounting for the features of R&D activities, the key to deal with the debt financing constraints still lies in the deficiency of support from long-term debt.

Table 3 is the regression results of political connections, debt financing and R&D intensity. In Model (3), the regression coefficient β_1 of LA is −0.71, the regression coefficient β_2 of LA*Pol is 0.005, and β_1 plus β_2 is −0.705, which is less than zero. It suggests that whether the firms have political connections affects the relationship between its debt ratio and R&D intensity, but the difference is small and not significant. In Model (4), the results about in-depth analysis of the debt maturity structure show that firms with political connections has reduced the negative impact of long-term loans for R&D intensity, relatively speaking, the firms with political connections can receive little more long-term loans to support R&D investment, but the regression coefficient β_1 plus β_2 ($-0.035 + 0.013$) is still less than zero, which suggests the small "resource effect" come from political connections cannot offset the constraints of long-term loans to R&D investment. And the regression coefficient of STD*Pol is −0.002, which reacts the "extrusion effect" of political connections. "Extrusion effect" means that the political connections between firms and government crowding out productive resources which can be used in R&D

investment (Xingqiang Du et al. 2012). The result is not consistent with our expectations. From these results, we can conclude that the political connections produce a certain "resource effect", but it cannot improve the firms' debt financing structure to help them go out of the plight of debt financing. On the contrary, political connections also bring "extrusion effect", to which enterprises should pay enough attention and introspect.

5 Conclusions and Policy Suggestions

This paper empirically studies the influence political connections and debt financing have on firms' R&D investment, and reveals the key why enterprises' R&D activities have been confronted with dilemmas of debt financing. It is suggested that there is an inverse correlation between the ratio of debt financing (bank loan) and the intensity of investment in research and development. By occupying a large amount of short-term debts, enterprises fail to reverse the dilemmas of debt financing, and the key restricting investment in R&D still lies in the deficiency of support from long-term debt. Although political connections bring certain long-term debt resources to enterprises, they fail to generate significant "resource effect" and drive enterprises' investment in research and development as expected. On the contrary, political connections also bring "extrusion effect", to which enterprises should pay enough attention and introspect themselves.

According to the analysis of the regression results, we put forward the following suggestions:

1. In the bank-based financial systems, firms' R&D activities are facing serious debt financing constraints. Therefore, we should accelerate the reform of the financial system and should speed up the development of the bond market, stock market, and small and medium-sized banks to broaden the financing channels for firms;
2. By occupying a large amount of short-term debts, firms fail to reverse the debt financing constraints, and the key still lies in the deficiency of support from long-term debt. Political connections fail to generate significant "resource effect" to improve the firms' debt financing structure. Improving firms' debt financing structure is a two-pronged effort by the firms. Themselves are at the micro level and the macro level is the reform of the financial markets;
3. Political connections also bring "extrusion effect", to which enterprises should pay enough attention and introspect themselves. Firms in the development process should correctly deal with the government-firm relations, and should continue to implement the strategy of "separating" market-oriented reforms and reducing the government intervention to the firms. Only allow firms to operate in accordance with the laws of market-oriented, can firms promote the long-term performance improvements and actively increase R&D investment.

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An Empirical Study on the Relationship Between Human Capital and Financial Capital—Taking the Information Industry and the Pharmaceutical a Shares of Listing Corporation as an Example

Fu-ying He

Abstract The knowledge-based enterprises were taken as samples based on the quarter data from 2003 to 2010 in this paper. There was a two-way dynamic role among the output, human capital and financial capital by using the vector autoregressive (VAR) model, the stationary test, co-integration analysis, granger-causality test, impulse response function and variance decomposition. Moreover, the human capital was more important than financial capital.

Keywords Financial capital • Human capital • VAR model

1 Introduction

The financial capital and human capital were two basic production factors, however, the latter was emphasized in the era of knowledge economy (Yang Shun Yong 2008). What's connection between the two basic factors and how to utilize the two factors effectively? The two questions above was the key to built efficient operation mechanism in the knowledge enterprise (Zhu Zhi Min 2009; Zhang Juan 2006). Therefore, the human capital and financial capital has been studied that how much contribution to the profit and what was their relation in this paper. The knowledge-based enterprises were taken as samples based on the quarter data from 2003 to 2010 in this paper (Zhang Xiaotong 2007).

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2 Study Design

2.1 Study Method

The relation between human capital and financial capital wasn't accurately illustrated currently (He fuying 2012), but the VAR model can be less restricted by the existing theory and could avoid the omitted variables. Regarding this facts, the VAR model was adopted to analyze the long-term dynamic effects between human capital and financial capital (Corolleur et al. 2004).

2.2 Variable and Data

It was used 3 variables: y, l, k, which y, income, was expressed by output, and which l, employee's wage and welfare, was taken as human capital, and which k, inventory and fixed assets, was represented financial capital because of the difference between actual capital and operating capital (Santos-Rodrigues et al. 2012). The logarithm of every variable was adopted to get stationary series easily, which could keep the characters of the data. The sample data was based on the quarter data from 2003 to 2010 of 80 information industry and the pharmaceutical A shares of listing corporation. The data come from Ruisi Database and were analyzed by using Ewiews6 (Kor and Leblebici 2005). The expression of VAR model was shown by equation as bellow.

$$X_t = A_1 X_{t-1} + \cdots + A_p X_{t-p} + \varepsilon_t \tag{1}$$

X_t is a vector that consisting of time series, $A_1 \ \ldots \ A_p$ and B was the coefficient matrix to be estimated, P was the autoregressive lag order, ε_t was the disturbance vector.

3 Empirical Research

3.1 Co-integration Analysis

First, the four order VAR model was established by the test of lag length criterion. It can be seen from Table 1 that the first-order difference of three time series was all stable.

Second, by using Johansen test, the result was shown that a long-run equilibrium relation among human capital, financial capital and output, which indicated that it existed 2 co-integration relationship at least among the 3 variables and the p-value was significant at 5 % level. The detail was shown as Table 2.

Table 1 ADF unit root test

Variable	Test type	ADF	1 % critical value	5 % critical value	10 % critical value	Conclusion
dlnk	(c,t,1)	−7.0264	−4.2967	−3.5684	−3.2184	Stable
dlnl	(c,t,1)	−13.3169	−4.3240	−3.5806	−3.2253	Stable
dlny	(c,t,1)	−3.5549	−4.3943	−3.6122	−3.2431	Stable

c denotes constant, *t* denotes trend, *l* denotes difference

In the results of Johansen test, it showed the standardized co-integrated vector on the premise of existing co-integrated relationship. The long-run equilibrium relationship among output, human capital and financial capital was expressed as bellow:

$$LNY_t = -0.842970 + 0.417377LNK_t + 0.705430LNL_t + \widehat{\mu}_t \tag{2}$$

$$\mathrm{t} = (2.21032) \quad (0.20443) \quad (0.12150)$$

In the long term, there was a co-integration relationship among output, human capital and financial capital. When human capital and financial capital each increased by 1%, output would increased of 0.71 % and 0.42 %, respectively. Therefore, the contribution of human capital to output was greater than that of financial capital, and it also showed the characteristics of IRS (increasing returns to scale).

3.2 Granger Test

In Table 3, LNL was the Granger cause of LNK in 93 % confidence level, not changed by LNK. Namely, the financial capital was determined by the human capital in the samples, but the inverse proposition was not true.

Furthermore, it was LNL that had bidirectional granger causality with LNY in the sample, but LNK hadn't this relation with LNY. Consequently, the relation between human capital and the output were mutual improved and cause-and-effect each other. That was to say that the internal and essential driver was form human capital rather than financial capital.

3.3 Mmodel Test

Because it was hard to explain the single parameter of VEC model (Dvorák and Prášková 2013), impulse response function and variance decomposition were utilized in the latter to omit the VEC model. When it came to model checking, one

Table 2 Johansen unrestricted co-integration rank test (trace and maximum Eigen value)

	Trace				Maximum Eigen value			
Nullhypothesis	Eigen-value	Statistic	5 % critical value	Prob.	Eigen-value	Statistic	5 % critical value	Prob.
None*	0.7650	71.1743	35.1928	0.0000	0.7650	39.1026	22.2996	0.0001
At most 1*	0.5955	32.0717	20.2618	0.0008	0.5955	24.4357	15.8921	0.0018
At most 2	0.2463	7.6360	9.1645	0.0967	0.2463	7.6360	9.1645	0.0967

*denotes rejection of null hypothesis at 5 % level

Table 3 Granger cause test

Null hypothesis:	Obs	F-statistic	Prob.
LNL does not Granger cause LNY	30	7.5752	0.0006
LNY does not Granger cause LNL		4.3019	0.0107
LNK does not Granger cause LNY	30	0.3996	0.8067
LNY does not Granger cause LNK		0.5332	0.7128
LNK does not Granger cause LNL	30	1.7988	0.1668
LNL does not Granger cause LNK		2.5976	0.0657

The lag ladder was 4

Table 4 The normal test of the residuals

Residual	Skewness	Kurtosis	Jarque-Bera	Probability	H0	Conclusion
RESID01	−0.09254	2.82297	0.07379	0.96378	Normal	Acceptance
RESID02	−0.25010	2.94981	0.28431	0.86749	Normal	Acceptance
RESID03	−0.27570	3.69635	0.88756	0.64161	Normal	Acceptance

Table 5 The forecast value and true value of the VEC model

	Predicted value			Actual value			Errorshi		
Period	LNY	LNK	LNL	LNY	LNK	LNL	LNY	LNK	LNL
2011Q1	20.7205	21.0716	18.2147	20.7429	21.0427	18.1757	−0.0011	0.0014	0.0021
2011Q2	20.7570	21.0890	18.1426	20.7893	21.0641	18.1569	−0.0016	0.0012	−0.0008

was lag ladder test and regression test of the residuals, the other was the normal test of the residuals. In the former test, the four ladder was all passed the lag exclusion test, and the residuals didn't exist the auto-regression phenomenon. In the latter test, the probability of the normal distribution that was three residuals were 0.96378, 0.86749 and 0.64161, which could be seen in Table 4.

Finally, from the out-of-sample forecast test of the VEC model, Table 5, we could see that the forecast error rate between the forecast value and the true value was less than 0.0022.

3.4 Impulse Analysis

The impulse response function refers to the response of a shock or innovation that a system impacts on one of its variables in the innovations of orthogonal processing, the influence of the variable ordering should be avoided, so the GIRF (generalized impulse response function), the improved method, was utilized. The impulse response function curve of VEC (4) model was shown as Fig. 1, which the horizontal axis represented the lag order and the vertical axis represented the degree of response that coming from the endogenous variables. The relationship between human capital (LNL) and financial capital (LNK) as follows:

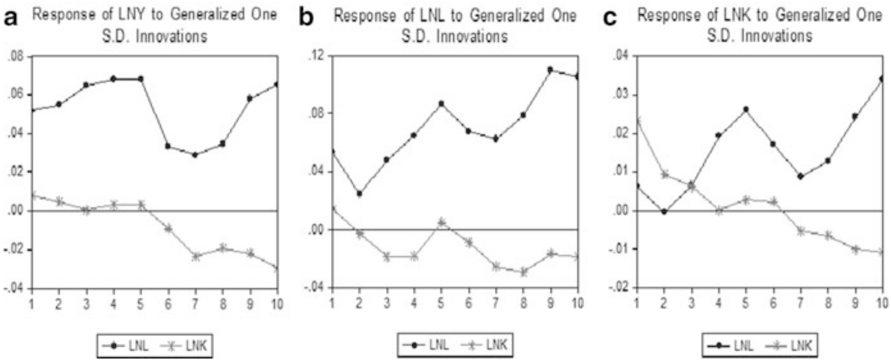

Fig. 1 The impulse response function curve of variables

First, as shown by the dotted line in Fig. 1a, the response of LNY to generalized on S.D. innovations of LNL was long-term positive effect in the lag period, LNY was accumulated by the pulling effect of LNL was 53.81 %. In addition, it was formed two peaks in the fifth to tenth lag period, maybe, the reason of this phenomenon was that the human capital was stimulated by the bonuses in the year-end bonuses, namely, the influence of the human capital on output was incentive, long-term, positive and significant increase. Whereas the most response of LNY to generalized on S.D. innovations of LNK was negative effect in the lag period, LNY was accumulated by the pulling effect of LNK was −8.32 %, which could be illustrated by the asteroid line in Fig. 1. From what had mentioned above, the root driver of the output was the promotion of the human capital rather than the financial capital.

Second, as shown by the dotted line in Fig. 1b, the response of LNL to generalized on S.D. innovations of himself was immediately shown a clear positive effect, which it was formed two peaks in the 5th to 9th lag period and LNL was accumulated by himself was 70.00 %. Nevertheless, as shown as asteroid line in Fig. 1b, the most response of LNL to generalized on S.D. innovations of LNK was negative effect in the lag period, LNL was accumulated by the pulling effect of LNK was −11.81 %, which indicated that the input in the financial capital would cause the inhibition of the human capital.

Lastly, as shown by the dotted line in Fig. 1c, the response of LNK to generalized on S.D. innovations of LNL was a slight positive effect, but the positive effect was very clear after the 2nd lag period. And LNK was accumulated by LNL was 15.45 %, while by itself was 1.21 %, moreover, LNK affected by itself was increasing negative except in former 6 years.

From what had analyzed above, with the time going, the shock of the human capital to the 3 variables were all lasting and more larger than that of financial capital, furthermore the trend of financial capital to 3 variables were all negative. In other words, Human capital was not only the lasting power for output but also the key to protecting and growing the financial capital.

Table 6 The cumulate effect of LNK and LNL

Effect factors	LNK (%)	LNL (%)	LNY (%)
LNK cumulate effect		0–12	0–12
LNL cumulate effect	7–21		0–15

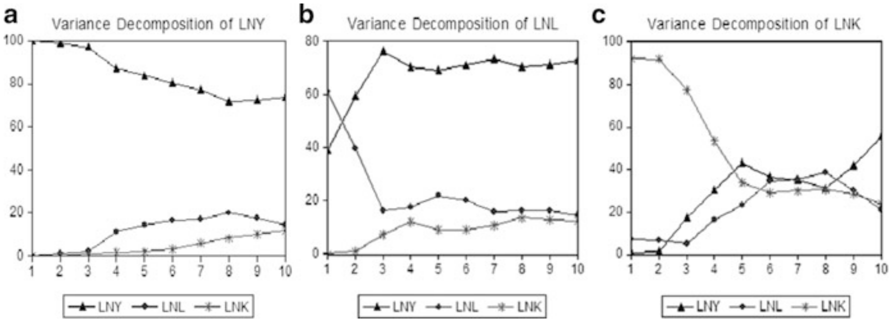

Fig. 2 The forecasting error curve of variance decomposition

3.5 Variance Decomposition

The relative importance of the random information was analyzed by Variance decomposition. As shown in Table 6 and Fig. 2, there was 0–15 % fluctuation of LNY was explained by human capital, while only 0–12 % fluctuation of LNY was explained by financial capital. So, human capital was more important for the fluctuation of LNY than financial capital. There was 0–12 % fluctuation of LNL was explained by financial capital, while 7–21 % fluctuation of LNK was explained by LNL. Therefore, it was obvious in the 3 variance decomposition that the explained strength of human capital was all greater than that of financial capital.

All in all, as far as the whole samples were concerned, human capital was more important for forecasting variance than financial capital.

4 Conclusions and Suggestions

As a whole, the human capital was more important than financial capital. On one hand, there was a bidirectional Granger Causality between human capital and output, which not occurred between financial capital and output. On the other hand, the contribution of human capital to output was greater than that of financial capital, and the importance of human capital could be illustrated by impulse response function and variance decomposition.

Because human capital was not only the lasting power for output (Fuying and Aijun 2011; Šlaus and Jacobs 2011), but also was the key to protecting and growing financial capital, there was a need to formulate corresponding countermeasure to arrange the right of human capital for corporate governance, which the short or loss of crucial human capital could be avoided. How to balance the corporate capital? The theory of capital structure was needed further development to solve the practical issue.

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The Application of Value Chain Analysis and Benchmarking in Cost Management

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Abstract Value chain analysis is a seeking tool for determining competitive advantage. It uses systematic methods to examine the activities and relationships of the enterprise to find the competitive advantage resources. Benchmarking is an evaluation of their own businesses and the mean to study other organizations. In this paper the value chain analysis and benchmarking can help managers to know which performance measures are most critical in determining their firm's overall success. They are important for cost management.

Keywords Benchmarking • Cost management • Future expectation • Value chain analysis

1 Introduction

In today's global and competitive economy, managers are challenged to provide high-quality goods and outstanding services at the lowest possible cost. Given the increasing pressure on the cost side, it is important for future managers to gain insight into the quality of cost information, and to understand how to measure and manage costs.

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Cost management and analysis is a subset of cost accounting. It is deals with cost data. Cost is the measurement of the economic resources that has already been made or is to be made in the future, in order to achieve a specific objective. Cost management is the process whereby companies use cost accounting to report or control the various costs of doing business. Cost analysis is concerned primarily with providing information to internal managers who are charged with planning and controlling the operations of the firm and making a variety of management decisions. Cost management and analysis deals with estimated future or planned costs as well as with past, historical costs. It involves the following basic phases: cost planning, cost control and cost management (Atkinson et al. 2004).

Cost planning involves selecting the goals of the organization and its subunits, expressed as operating objectives, and then identifying the means of accomplishing them (Drury 2004). Plans are summarized in budgets, which are expressed in terms of money and measurements. A budget also achieves control through the comparison of actual and budgeted costs, providing variance determination and analysis.

Cost control sets predetermined standards by which performance can be measured. Cost control then reports differences between planned and actual performances to direct attention to what went wrong (Drury 2004). Cost control aids in fixing responsibility for departures from a plan so that corrective actions can be taken.

Cost management for decision making this phase involves the measurement of accurate and relevant cost data and analyzing such information for decision making. Activity based costing (ABC) and just in time (JIT) costing are two new developments that enhance product-costing accuracy. Decision making, which can also be termed problem solving, is largely a matter of choosing between alternative courses of action. A cost management system is used to support management's needs for better decisions about product design, pricing, marketing, and mix, and to encourage continual operating improvements (Drury 2004).

The objective of this literature is to assist to provide a broad overview, defining value chain analysis and benchmarking, introducing key concepts and discussing the contribution of them as analytical and policy tool. Moreover, discuss the limitation and expectation of using value chain analysis and benchmarking.

2 Definition and Function of Value Chain Analysis

To survive in today's highly competitive business environment, any organization must achieve, at least temporarily, a competitive advantage. A low cost/price strategy focuses on providing goods or services at a lower cost than the competitor, or superior goods or services at an equal cost. Increasing attention is now being given to value chain analysis is a means of increasing customer satisfaction and managing costs more effectively (Kaplinsky and Morris 2000). It is linked set of value creating activities all the way from basic raw material sources for component suppliers through to the ultimate end-use product or service delivered to the customer. A value chain describes the full range of these activities.

3 Contrast Various Concept of Value Chain Analysis

This is a considerable overlap between the concept of a value chain and similar concepts. One important source of confusion, particularly in earlier years before the value chain as outlined above became increasingly widespread in the research and policy domain was one from Michael Porter in the mid 1980s. Porter distinguished two important elements of modern value chain analysis:

The various activities which were performed in particular links in the chain. Porter (1985) drew the distinction between different stages of the process of supply (inbound logistics, operations, outbound logistics, marketing and sales, and after sales service), the transformation of these inputs into outputs services the firm marshals to accomplish this task (strategic planning, human resource management, technology development and procurement) (Porter 1985). The importance of separating out these various functions is that it draws attention away from an exclusive focus on physical transformation. These functions need not be performed within a single link in the chain, but may be provided by other links. Porter refers to these essentially intra-link activities as the value chain.

Porter complements this discussion of intra-link functions with the concept of the multi-linked value chain itself, which he refers to as the value system. The value system basically extends his idea of the value chain to inter-link linkages.

In essence, therefore, both of these elements in Porter's analysis are subsumed by modern value chain analysis. The primary issue is one of terminological confusion, and this problem is exacerbated by Womack and Jones in their influential work on lean production. They similarly use the phrase value stream to refer to what most people now call the value chain.

Another concept which is similar in some respects to the value chain is that of the filiere (whose literal meaning in French is that of a "thread"). It is used to describe the flow of physical inputs and services in the production of a final product (a good or a service), and in term of its concern with quantitative technical relationships, is essentially no different from Porter. French scholars build on analyses of the value added process in US agricultural research to analyses the processes of vertical integration and contract manufacturing in French agriculture during the 1960s. During 1980s, filiere analysis factored in the contributory role of public institutions into what were essentially technical quantitative relationships, thereby bringing it analytically closer to value chain analysis. However, filiere analysis tended to be viewed as having a static character, reflecting relations at a certain point in time. It does not indicate growing or shrinking flows either of commodity or knowledge, nor the rise and fall of actors. Although there is no conceptual reason why this should have been the case, in general filiere analysis has been applied to the domestic value chain, thus stopping at national boundaries.

A third concept which has been used to describe the value chain is that of global commodity chains, introduced into the literature by Gereffi during the mid-1990s. Gereffi's contribution has enabled important advances to be made in the analytical and normative usage of the value chain concept, particularly because of its focus on the power relations which are imbedded in value chain analysis. By explicitly focusing on the coordination of globally dispersed, but linked, production system, Gereffi has shown that many chains are characterized by a dominant party who determine the overall character of the chain, and as lead firm becomes responsible for upgrading activities within individual links and coordinating interaction between the links.

A value chain framework of Michael Porter is a model that helps to analyze specific activities through which firms can create value and competitive advantage. A value chain analysis is use to analyze, coordinate and optimize linkages in the value chain. Coordinating the individual parts of the value chain together creates the conditions to improve customer satisfaction, particularly in terms of cost efficiency, quality and delivery. A firm that performs the value chain activities more efficiently, and at a lower cost than its competitors will gain competitive advantage. Therefore it is necessary to understand how value chain activities are performed and how they interact with each other.

The activities are not just a collection of independent activities but also a system of interdependent activities in which the performance of one activity affects the performance and cost of other activities. The linkages in the value chain express the relationships between the performance of one activity and its effects on the performance of another activity. A linkage occurs when interdependence exists between activities and the higher the interdependence between activities the greater is the required coordination (Donelan and Kaplan 1998).

Thus, it is appropriate to view the value chain from the customer's perspective, with each link being seen as the customer of the previous link. If each link in the value chain is designed to meet the needs of its customers, then end customer satisfaction should ensue.

4 Challenges of Value Chain Analysis

There is a challenge in using value chain analysis. Traditional accounting systems are not designed for classifying costs by value activities. But with newer accounting systems, such as those based upon activity-based costing, this type of cost classification problem can be solved. Therefore, strategic planning is essential to their operations and their survival. Value chain analysis is an important tool for strategic management, and when competition is intense, companies must manage activities and costs strategically, or they will lose their competitive advantages (Donelan and Kaplan 1998).

Firstly, a firm may create a cost advantage either by reducing the cost of individual value chain activities or by reconfiguring the value chain. Once the value chain is defined, a cost analysis can be performs by assigning costs to the value chain activities. The costs obtained from the accounting report may need to be modified in order to allocate the properly to the value creating activities. A firm develops a cost advantage by controlling these drivers better than do the competitors.

Secondly, differentiation also can be as an advantage arises from any part of the value chain. For example, procurement of inputs that are unique and not widely available to competitions can create differentiation, as can distribution channels that offer high service levels. Differentiation stems from uniqueness. A differentiation advantage may be achieved either by changing individual value chain activities to increase uniqueness in the final product or by reconfiguring the value chain.

Thirdly, Technology is employed to some degree in every creating activity; changes in technology can impact competitive advantage by incrementally changing the activities themselves or by making possible new configurations of the value chain. Technologies related to training, computer-aided design, and software developments frequently are employed in support activities. To the extent that these technologies affect cost drivers or uniqueness, they can lead to a competitive advantage.

5 Limitation of Using Value Chain Analysis for Cost Management

Kaplinsky and Morris indicated value chain analysis overcomes a number of important weaknesses of traditional sectoral analysis, which tends to be static and suffers from the weakness of its own bounded parameters. For in restricting itself to sectoral analysis, it struggles to deal with dynamic linkages between productive activities that go beyond that particular sector, whether they are of an inter-sectoral nature or between formal and informal sector activities. Value chain also goes beyond the firm-specific of much of the innovation literature. By its concentration on their linkages it allows for an easy uncovering of the dynamic flow of economic, organizational and coercive activities between producers within different sectors even on a global scale.

Furthermore value chain analysis is particularly useful for new producers-including poor producers-who are trying to enter global markets in a manner which would provide for sustainable income growth (Kaplinsky and Morris 2000). Finally value chain analysis is also useful as an analytical tool in understanding the policy environment which provides for the efficient allocation of resources within the domestic economy, though its primary use as an analytic tool for understanding the way in which firms participate in the global economy.

6 Improve Management of Value Chain Analysis

Organizations achieve a competitive advantage by managing the value chain better than other institutions in their industry. Managing the value chain implies increasing the quality of products and services, while reducing the institution's costs and increasing revenue, thus increasing competitive advantage. Examining a firm's value chain and comparing it to those of key rivals indicates areas of cost advantage or disadvantage. By contrast, a strategy based on seeking cost leadership will require a reduction in the costs associated with the value chain activities, or a reduction in the total amount of resources used (Hogue 2001).

Value chain analysis is a framework that can provide a number of benefits to the management of organizations. This analysis can help managers of these organizations to identify linkages between value activities within the organization, and to think in terms of process rather than function or department (Juran and Dershin 2002). Through analysis of the value system, managers can identify potentials for strategic alliances with various actors in the industry value system. Identification of cost drivers and linkage with value chain activities help managers focus on cost reduction and on finding ways to optimize returns throughout the value chain. As well, value chain analysis helps managers understand cost management problems. Failure to see the impact of a decision on the overall value chain will result in missed opportunities.

7 Definition of Benchmarking and Its Process

Benchmarking is a self-improvement tool for organizations (Elnathan et al. 1996). It allows them to compare themselves with others, to identify their comparative strengths and weaknesses and learn how to improve. It is cost beneficial since an organization can save time and money avoiding mistakes that other companies have made. It is a way of studying and adopting best practices.

In order to identify the best way of performing activities and business processes organizations are turning their attention to benchmarking, which involves comparing key activities with world class best practices. Benchmarking attempts to identify an activity, such as customer order processing, that needs to be improved and finding a non-rival organization that is considered to represent world-class best practice for the activity and studying how it performs the activity. The objective is to find out how the activity can be improved and ensure that the improvements are implemented (Elnathan et al. 1996).

The process of studying and adapting the best practices of other organization to improve the firm's own performance and establish a point of reference by which other internal performance can be measured. It is a way for organization to gather information regarding the best practices of others. It is often highly cost-effective, as organization can save time and money by avoiding the mistakes that other companies have made or by not reinventing a process or method that other companies have already developed and tested. Thus, selecting appropriate benchmarking partners is a critical aspect of the process. The benchmarking process typically consists of five stages that include several organizational, operational, and informational factors. They are: Self-assessment. Document and study your own organization's vision, practices, and success measures. Decide what to benchmark.

Comparison. Decide whom to benchmark. Identify exemplars and establish a benchmarking partnership. Study and assess your partners.

Analysis and adaptation. Ask why you are getting your results and why others are getting better results. While benchmarking is often called "borrowing shamelessly," practices generally require creative adaptation in a new context.

Implementation. Think carefully about what enablers (e.g., resources, schedule changes) are needed. Communicate findings and build support for the changes you want to make.

Feedback. Carefully monitor and measure the results of your innovation and recalibrate if necessary (Elnathan et al. 1996).

Benchmarking can be described as a structured process. The structure of the benchmarking process is often developed by the development of a step by step process model, which provides a common language within organizations. Choosing an optimal benchmarking partner requires a deep understanding of the process being studied and of the benchmarking process itself. By thoroughly grasping the process are reviewing, establish a reliable baseline of comparison.

8 Internal Benchmarking and External Benchmarking

Benchmarking against internal operations is called internal benchmarking (Matter and Evans 1999). Within an organization, different units that perform the same activities are compared. The unit with the best performance for a given activity sets the standard. Other units then have a target to meet or exceed. Furthermore, the best practices unit can share information with other units on how it has achieved its superior results.

Internal benchmarking has several advantages. First, a significant amount of information is often readily available that can be shared throughout the organization. Second, immediate cost reductions are often realized. Third, the best internal standards that spread throughout the organization become the benchmark for comparison against external benchmarking partners. This last advantage also suggests the major disadvantage of internal benchmarking. Specifically, the best internal performance may fall short of what others are doing particularly direct competitors.

There are numerous examples of the benefits of internal benchmarking. Thomson Corporation collected and broadcast best practices through internal benchmarking throughout the company and saved $200 million in 1 year. Chevron saved $150 million by transferring energy use management techniques throughout the company. Public Service Enterprise Group used internal benchmarking to improve the process for ripping up a street, repairing a line, backfilling the hole, and repaving the area. The improvement dropped costs from an average of $2,200 to just $200 per incident (Wouters et al. 1999).

Benchmarking that involves comparison with others outside the organization is called external benchmarking (Matter and Evans 1999). The three types of external benchmarking are competitive benchmarking, functional benchmarking, and generic benchmarking. Competitive benchmarking is a comparison of activity performance with direct competitors. The main problem with competitive benchmarking is that it is very difficult to obtain information beyond that found in the public domain. At times, however, it is possible.

The Ritz-Carlton, for example, dramatically improved its housekeeping process by studying the best practices of a competitor. Functional benchmarking is a comparison with firms that are in the same industry but do not compete in the same markets. For example, a Japanese communications firms might be able to compare its customer service process with that of AT&T. generic benchmarking studies the best practices of non-competitors outside a firm's industry. Certain activities and processes are common to all organizations. If superior external best practices can be identified, then they can be used as standards to motivate internal improvements. For example, Verizon improved its field service process by studying the field service process of an elevator company (Elnathan et al. 1996).

9 Analysis Benchmarking Performance for an Organization

Sarkis outlines from a manager's perspective that benchmarking has been defined as a continuous, systematic process for evaluating the products, services and work processes of organizations that are recognized as representing best practices, for the purpose of organizational improvement.

A working definition of lead benchmarking is benchmarking which focuses on analyzing forward looking, predictive and future performance comparisons. Process models are generically derived from literature grounded within existing theory, and they therefore, comprise some limitations in relation to carrying out benchmarking within today's dynamic organizational environment. These traditional benchmarking processes are useful in aiding incremental and anticipated planned changes, which are necessary for benchmarking to be fully developed in the context of revolutionary and unanticipated change.

UK company involvement in benchmarking ranges from 60, 78 and 85 %. Evidence from a more recent survey suggests that most using benchmarking will be involved in comparisons of performance rather than the more rigorous style of process benchmarking (Elnathan et al. 1996). This therefore, indicates the popularity of performance measures and how they are critical elements within benchmarking organizations today and indeed, how important it is for organizations to use lead measures within benchmarking.

Traditionally, performance measures and performance measurement systems have been designed and managed by accounting and finance functions within organizations. This has caused organizations to manage most of their projects on the basis of outdated cost and finance oriented lagging measurements. The selection of performance measures to be used are imminent to the success of business management and indeed, organizational performance. Performance measures instigate the management of change, which is necessary to enable organizations to survive in agile environments. Organizations must be flexible and able to adapt to unanticipated change, which in the long run will improve organizational competitiveness and determine agility success (Wouters et al. 1999). Performance measures used for lead benchmarking need to be linked to an organization's strategy and the dynamic business environment. To develop this theory further, there is a need for predictive or lead benchmarking.

Leading benchmarking organizations should be extending beyond internal/external, financial/non-financial performance measures and focusing on benchmarking their lead performance measures are proactive and preventive in nature. These measures help anticipate and impact future desired results. They are needed to drive performance throughout the organization and they furnish information on incremental steps towards larger goals. Clearly, opportunities for creating value are shifting from managing tangible assets to managing knowledge based strategies that develop an organization's intangible assets: customer relationships, innovative products and services, high quality and responsive operating processes, information technology and databases, and employee capabilities, skills and motivations.

Today's dynamic environment, where intangible assets have become the major sources of competitive advantage, requires tools that describe knowledge based assets and the value creating strategies that these assets make possible. These intangible assets are important elements within lead benchmarking.

The lead benchmarking technique will enable organizations to develop core competencies that will help organizations to sustain competitive advantage, such as enabling new markets or developing new products; and creating an organization that is more capable of learning how to respond in an uncertain future because it has increased its acceptance of change (Young 2003). The bridge to the future is that an organization learns today and in its ability to apply the process rapidly for growth in the future. Therefore, it has become apparent that lead, forward looking, predictive benchmarking will have to be developed.

However, benchmarking also come a number of limitations. They are high level in scope and are not the answer to the problem. It is as qualitative tools are universal and not industry, geographic, or size centric, and may not have a sufficient amount of data for very specific benchmark group comparisons. In another hand, some questions may not be relevant to the organization or business process, they are not detailed enough to be used for implementation phases of projects.

10 Future Expectation of Benchmarking

Formal programs for benchmarking in general, and for benchmarking training specifically, were also highly important areas likely to be further develop. These might be signals that benchmarking is about to be increasingly institutionalized and become an integral part of running businesses. The use of companies in benchmarking, both for information sharing internally and externally, and for partnering and searching for best practices seems to be of some growth. On the other hand, direct contact with other companies and firsthand observation of best practices still seem to be the preferred method (Camp and Andersen 2004).

Benchmarking has virtually exploded since 1979 when Xerox first introduced it (Camp and Andersen 2004). Today, benchmarking as a tool is widely used. It has spread geographically to large parts of the world and proliferated in a variety of manufacturing and service businesses to achieve the highest levels of performance, establish the best processes and increase competitiveness in order to enjoy higher profits. Benchmarking uses best practices found within and outside the organization as the standard for evaluating and improving activity performance. The objective of benchmarking is to become the best at performance activities and process, thus, benchmarking represents an important activity management methodology. The approach certainly seems to have considerable advantages.

A benchmark is a standard of performance. As a financial management improvement strategy, benchmarking helps organizations to identify standards of performance in other organizations and import them successfully to their own. It allows organizations to discover where they stand in relation to others (Francis et al. 2002). By identifying, understanding, comparing, and adapting one's own organization with the outstanding practices and processes of others, an organization can target problem areas, best levels of performance, and solutions to improve results.

Organizations that accomplish a particular activity at the highest value, such as functioning at the lowest cost or greatest efficiency and producing the highest quality, are considered "Best-in-Class." In determining what qualifies as world-class, benchmarking ask the question: "who are we now, and who do we want to be?" The best benchmarking efforts do not simply match the performance of others; they are motivated to exceed it (Francis et al. 2002).

11 Conclusion

The business environment has evolved dramatically over the past four decades, which has caused almost every aspect of organizations and management to change accordingly. Atkinson has outlined similar elements which have caused and indeed contributed to the changes in the business environment. These include the changing nature of work, increased competition, specific improvement initiatives, national and international quality awards, changing internal and external demands, accelerated technological advancement, changing organizational roles and the acceleration of globalization. In today's highly competitive construction industry, there is a critical need for managers to continuously improve their firm's efficiency and effectiveness. More specifically, managers need to know which performance measures are most critical in determining their firm's overall success.

Cost management is a strategic process that focuses on the customer and on profitability. Understand what causes the cost and revenue structure of the business. This is the most critical item in cost management. Many companies do not have accurate information on what their true costs are. Increase effectiveness is continuously improving Costs. Redefine the company's cost structure to select the costs that generate profit. Cost management must become standard operating procedure. Management and employees must be constantly identifying opportunities for eliminating or reducing unprofitable work. Every company needs to have a long-term business strategy. Cost management should be part of the strategy and be influenced by the strategy. Cost decisions should be measured against the company's strategy, rather than a current short-term situation.

Effective cost management is the central measure of accountability for business leadership. Cost management includes effective strategy implementation as well as providing the resources and process discipline to enable and ensure the highest possible level of quality, reliability and productivity at the lowest overall cost (Merchant and Vanderstede 2003). It is not about "cost" in the sense of "cutting cost." Rather, cost management is the process of optimizing performance. It is as much strategic as it is operational. The most important principle of effective cost management is leadership's understanding and acceptance of the reality that the majority of all organizational cost is structural. That is, costs are built into an organization by management systems and management decisions. Decisions about the number of products, the customers they serve and the way the business is run all drive cost. It is "what we do" versus "how well we do it" that determines the vast majority of an organization's cost. In the end, effective, process-driven cost management is founded in the culture of the company. It is a way of life. In many cases it is also the only path to organizational survival.

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Capital Structure and Growth: Evidence from China's Listed Companies

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Abstract Using the annual data of China's listed companies of manufacturing industry from 2006 to 2011, we establish panel data models and make regression analysis to study the capital structure and capital policy of growing firms. When associated variables controlled, empirical results show that the debt ratio is higher in growing firms, especially long term debt, and the cash holdings and dividend is lower in growing companies. Our result reveals that growing firms make full use of capital inside and outside the companies and the growth of the firms needs the support of debt, especially long term debt.

Keywords Capital structure • Cash holdings • Dividend • Growth

1 Introduction

A proper capital structure plays an important role in the operation of a company, especially when the firms are in the phase of growing, appropriate capital structure can make good use of each kind of capital to provide enough funds to support growth. Many researchers have studied the capital structure of growing firms, each theory has its own explanation. The pecking order theory suggests that growing companies use internal funds so that the debt ratio is low (Myers 1977); The agency theory points out that managers of growing companies may adopt low debt so as to decrease the risk of bankruptcy (Jensen 1986); The financial flexibility theory suggests that when a firm is in growing period, it will make use of financial flexibility and finance with debt so that the debt ratio is high (Byoun 2011).

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As for China's listed companies, some research have analyzed the relationship between capital structure and growth and three different results have been reached: the correlation between growth and the debt ratio is positive (Hui-fang Cheng and Yong Xing 2003; Zuo-ping Xiao 2005); negative (Tao Yu 2007; Shi-nong Wu et al. 1999) and no correlation (Zheng-fei Lu and Yu Xin 1998; Xi-xi Hong and Yi-feng Shen 2000). These studies adopt different theories and methods, but there analysis about the capital structure only use debt ratio, regardless of the allocation of the internal funds. We consider debt ratio and internal funds involving cash holdings and dividend together to analyze the capital structure and finance policy of growing companies in order to find the appropriate capital structure and finance policy to promote growth.

2 Research Design

2.1 Hypothesis

Traditional capital structure theories put forward suggestions from different aspects and they proved that there exists an optimal capital structure for each company. But many empirical research find that debt ratios of some firms are not in line with predictions (Graham and Harvey 2001; Minton and Wruck 2001). Recent years, some research put forward a new theory that can explain this puzzle, they suggested that companies keep conservative finance policy to keep low debt ratio in order to get financial flexibility to remain space for debt finance in future when better investment opportunities emerge (DeAngelo and DeAngelo 2007; Marchica and Mura 2010; Denis and McKeon 2011). According to the theory of financial flexibility, companies keep low debt ratio to get financial flexibility and when growing, firms make use of the financial flexibility to finance with debt, so the debt ratio of growing firms is high (Byoun 2011). And we suggest that growth needs long term investment to promote, and long term investment needs long capital to support, hence when growing, the increasing of debt should mainly consists of long term debt. Additionally, growing firms make full use of all kinds of funds inside and outside companies, while debt increasing, firms keep low cash holdings and pay low dividend to maintain more funds to invest to grow.

According to the analysis above, we put forward our hypothesis:

Hypothesis 1: Debt ratio is high in growing firms, especially long term debt ratio.
Hypothesis 2: Cash holdings are low in growing firms.
Hypothesis 3: Dividend is low in growing firms.

2.2 Models and Variable

In order to test hypothesis 1, 2 and 3, we set up models using the experience of Byoun (2011). The models are as follows:

$$\begin{aligned} Debt_{it}/LongDebt_{it} = c + \alpha\, Growth_{it}\,(or\ Gr_{it}) + \beta_1\, Asset_{it} \\ + \beta_2\, Cashflow_{it} + \beta_3\, Guarantee_{it} + \beta_4\, ROA_{it} + \varepsilon_{it} \end{aligned} \quad (1)$$

$$\begin{aligned} Cashholdings_{it} = c + \alpha\, Growth_{it}\,(or\ Gr_{it}) + \beta_1\, Asset_{it} \\ + \beta_2\, Cashflow_{it} + \beta_3\, Guarantee_{it} + \beta_4\, ROA_{it} + \varepsilon_{it} \end{aligned} \quad (2)$$

$$\begin{aligned} Dividend_{it} = c + \alpha\, Growth_{it}\,(or\ Gr_{it}) + \beta_1\, Asset_{it} \\ + \beta_2\, Cashflow_{it} + \beta_3\, Guarantee_{it} + \beta_4\, ROA_{it} + \varepsilon_{it} \end{aligned} \quad (3)$$

The meaning and calculation of each variable is explained as follows.

2.2.1 Dependent Variables

Debt: Debt ratio, equals Total debt /Total assets. Debt ratio is the most commonly used variable when capital structure is analyzed.

LongDebt: Long term debt ratio, equals Long term debt/Total assets. We suggest that the growth of a firm is promoted by long term investment, while long term investment is supported by long capital. Liabilities include short term debt and long term debt, it should be long term debt that promotes growth more, so it is necessary to analyze long term debt.

Cashholdings: Cash that be kept in company in forms of cash and cash equivalents, equals (Monetary funds + Marketable securities)/Total assets. Growing firms keep low cash holdings so as to invest more to promote growth.

Dividend: Dividend paid to shareholders, equals Dividend/Total assets. Growing firms may pay low dividend to remain more profit to provide capital to support growth.

2.2.2 Independent Variables

Growth: Prime operating revenue growth rate, equals (Prime operating revenue of 1 year − Prime operating revenue of last year)/Prime operating revenue of last year. How to measure growth, similar research use many indicators including total asset growth rate, net income growth rate and prime operating revenue growth rate. While the development of a company depends more on prime operating business, the growth of total asset and net income includes the growth of other parts, including revenues from other operating business and non-operating activities. But the revenues from other operating business and non-operating activities contributes little to the growth of company, so the company may not make long strategy to support the revenue. And the prime operating revenue contributes the growth of a company, so the company makes capital strategy to support prime operating business. So we use prime operating revenue growth rate to measure the growth of a company.

Gr: Dummy variable indicating growing firm. Due to the fluctuation of market and the arrangement of investment time schedule, the prime operating revenue growth rate fluctuates. Even in the period when the firm is growing, there may be one or two years when prime operating revenue growth rate is low. In order to decrease the influence of fluctuation, we classify firms according to the prime operating revenue growth rate. First we calculate the average growth rate, then we compare each firm's growth rate with the average rate. If a firm's growth rate is higher than the average figure over half of the sample years, we classify this firm growing firm. Otherwise, ungrowing firm. We add the dummy variable *Gr* to the model. If the firm is growing firm, *Gr* is 1; otherwise, *Gr* is 0.

2.2.3 Controlling Variables

Using the experience of past research, we add four controlling variables, including firm size, operating cashflow, guarantee ability and profitability.

Size: Firm size, equals Total assets/10^9. Large companies have stronger ability to defend risk than small firms, so debt ratio of large companies may be high.

Cashflow: Operating cash flow, equals Net cash flow from operating activities/Total assets. Cash flow from operating activities reflects the ability of financing inside the company. Firms with high cash flow may use internal funds and have low debt ratio.

Guarantee: Guarantee ability, equals (Fixed assets + Inventory)/Total assets. Firms with high guarantee ability can finance more easily and may have high debt ratio.

ROA: Return on Total assets, equals Net profit/Total assets. Firms with high *ROA* can produce more funds and have low debt ratio.

According to the analysis of hypothesis, growing firms may have high debt ratio and low cash holdings and low dividend, the correlation between debt ratio and cash holdings (also dividend) is negative. The impact of these four controlling variables on cash holdings and dividend is contrary to the impact on debt ratio and the analysis on detail is omitted here.

3 Empirical Result

3.1 Data

We use the annual financial data of manufacturing industry companies of China's A shares listed companies from 2006 to 2011 as the initial samples. In order to keep the data easy to compare, we exclude those companies that have been listed later than 2006, thus each sample company has the data from 2006 to 2011. And we exclude ST companies and those companies whose critical data missed. At last we get the panel data of 3,696 observations of 616 companies. All the financial data we use is down from Wind Data. We use stata12.0 to process the data analysis.

3.2 Descriptive Analysis

The descriptive analysis of variables is shown in Table 1. We can see that the average of debt is 51.52 %, while long debt is 15.55 %, this reveals that companies use more current debt than long term debt. And the standard deviation of long debt is 16.757 %, larger than the average of 15.55 %, the maximum is 77.534 %, and the minimum figure is 0, this shows that the fluctuation of long debt is large and the difference between companies is large.

We take further discussion about the difference between growing and ungrowing companies. Table 2 shows the compare of the average of each variable between growing companies and ungrowing companies. We identify those companies whose growth rate is higher than average over half of the sample years as growing companies. We have 1,698 observations of 283 growing companies and 1,998 observations of 333 ungrowing companies. Table 2 shows that the long debt ratio of growing firms is 17.787 %, significantly higher than the 13.656 % of ungrowing companies. As for total debt ratio, the growing companies have the average debt ratio of 52.804 %, significantly higher than 50.434 % of ungrowing companies. For

Table 1 Descriptive analysis

Variables	Observations	Average	STDEV	Maximum	Minimum
LongDebt (%)	3,696	15.552	16.757	77.534	0
Debt (%)	3,696	51.522	18.041	99.965	9.654
Growth (%)	3,696	19.297	33.084	198.11	−61.122
Cashholdings	3,696	0.155	0.101	0.511	0.003
Dividend	3,696	0.229	0.559	4.813	0
Size	3,696	5.816	10.436	68.769	0.121
Cashflow	3,696	0.052	0.072	0.269	−0.161
Guarantee	3,696	0.469	0.155	0.908	0.001
ROA (%)	3,696	6.481	7.432	38.179	−27.311

Table 2 Compare between growing firms and ungrowing firms

	Observations	Growth (%)	Cashholdings	LongDebt (%)	Debt (%)	Guarantee	Cashflow	Size	Dividend	ROA (%)
Ungrowing	1,998	13.213	0.159	13.656	50.434	0.463	0.049	4.222	0.235	5.502
Growing	1,698	26.464	0.150	17.787	52.804	0.476	0.054	7.694	0.222	7.632
P-value		(0.000)	(0.005)	(0.000)	(0.000)	(0.008)	(0.028)	(0.000)	(0.485)	(0.000)

Table 3 Regression results of models

	LongDebt (1)		Debt (2)		Cashholdings (3)		Dividend (4)	
Gr	3.202		2.484		−0.011		−0.015	
	(0.002)		(0.035)		(0.057)		(0.528)	
Growth		0.019		0.036		−0.001		−0.001
		(0.002)		(0.000)		(0.263)		(0.000)
Cashflow	−12.029	−12.031	−0.707	−0.923	0.171	0.171	0.058	0.041
	(0.000)	(0.000)	(0.768)	(0.699)	(0.000)	(0.000)	(0.677)	(0.769)
Guarantee	4.809	4.689	13.607	12.877	−0.325	−0.325	0.039	0.055
	(0.013)	(0.015)	(0.000)	(0.000)	(0.000)	(0.000)	(0.575)	(0.423)
Size	0.422	0.434	0.245	0.252	0.001	−0.001	0.003	0.003
	(0.000)	(0.000)	(0.000)	(0.000)	(0.004)	(0.007)	(0.014)	(0.010)
ROA	−0.195	−0.223	−0.397	−0.461	0.001	0.001	−0.004	−0.002
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.009)	(0.190)
Constant	11.067	12.323	44.969	46.132	0.293	0.289	0.223	0.219
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
R^2	0.106	0.103	0.149	0.163	0.266	0.264	0.003	0.007

The P-values are provided in parentheses

cash holdings, growing companies have the average cash holdings to total assets of 0.150, significantly lower than 0.159 of ungrowing companies. The dividend to total assets of growing firms is 0.222, lower than 0.235 of ungrowing companies, but not statistically significant. The analysis above reveals that the debt ratio and long debt ratio is significantly higher than ungrowing companies, and cash holdings is significantly ower than ungrowing companies, dividend of growing companies is lower than ungrowing companies, though not significant, this result is consistent with our hypothesis.

3.3 Empirical Results

This part analyzes the influence of growth on debt ratio (including long term debt ratio), cash holdings and dividend. Table 3 column (1) shows that when the dependent variable is long term debt ratio, the dummy variable of growing company is 3.202, the P value is 0.002, this shows that the long term debt ratio of growing companies is higher than ungrowing companies. And the coefficient of prime operating revenue growth rate is 0.019, the P value is 0.002, this shows that with the increasing of prime operating growth rate, the long term debt ratio becomes higher.

Table 3 column (2) shows that when the dependent variable is total debt ratio, the dummy variable indicating growth companies is 2.484, the P value is 0.035 and the coefficient of growth rate is 0.036, the P value is 0, this shows that the total debt ratio is influenced by the growth, which is consistent with Byoun (2011), which points out that growing firms use more debt.

Table 3 column (3) shows that when the dependent variable is cash holdings, the dummy variable of growth companies is −0.011, the P value is 0.057, this shows that growing companies decrease cash holdings significantly. But when the independent variable is prime operating revenue growth rate, the coefficient is −0.001, the P value is not significant of 0.263. This shows that the cash holding between growing and ungrowing firms is different, but it does not decrease with the increase of prime operating revenue growth rate.

When the dependent variable is dividend, as is shown in Table 3 column (4), the dummy variable is −0.015, the P value is 0.528. Though the coefficient is negative, it is not significant. And the coefficient of prime operating revenue growth rate is −0.001, the P value is 0. This shows that the dividend decreases with the increase of prime operating revenue growth rate, but it cannot be significantly proved that the dividend of growing companies is lower than ungrowing companies. This may be due to the irregularity of dividend payment of China's listed companies (Lei Wang 2012).

4 Conclusion

We use the annual financial data of China's listed companies to analyze the influence of growth on capital structure and get the empirical results as follows: (1) Debt ratio of growing companies is higher than ungrowing companies. (2) Cash holdings of growing companies is lower than ungrowing companies at a weak significant level. (3) Dividends of growing companies is lower than ungrowing companies at a weak significant level.

The empirical results reveal that growing companies make full use of funds inside and outside the companies. Growing firms increase debt, especially long term debt. And at the same time, they decrease cash holdings to put more funds to invest. And they also decrease dividend payment to remain more profit to promote growth.

According to the results above, growth of China's listed companies is supported by debt finance, so financial market, especially debt market should be developed to provide more financing ways for companies.

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Optimal Stopping of the Compound Binomial Model with Capital Injection Controlled by Optimal Dividend Strategy

Tong-ge Wang, Ya Liu, and Da-jun Sun

Abstract We consider the optimal stopping problem, based on the compound binomial model with capital injection controlled by optimal dividend strategy. First, the value function *V(x)* is established. Second, via the Bellman equation satisfied by the value function *V(x)* which maximizes the discounted value of define between dividend payment and the penalized discounted capital injection, we find the optimal stopping time $\tau*$. Furthermore an optimal stopping model with capital injection in order to maximize the shareholders' interests is obtained.

Keywords Bellman equation • Compound binomial model • Capital injection • Dividend injection • Optimal stopping

1 Introduction

Risk theory is the most theoretical part of actuarial mathematics. Mainly used in insurance, finance, securities investment and risk management etc. It constructs the mathematical model by means of probability and random process theory to describe all kinds of risk.

The earliest risk model with dividend was proposed by De Finetti (1957) in the 15th world actuarial science conference. He thinks the company should seek

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maximization of the discounted dividend before the bankruptcy, and finally proves that the optimal dividend strategy is a boundary strategy. Sethi and Taksar (2002) point out that the optimal strategy should consider both dividend and capital strategy. Simply put, we should consider dividend when the company surplus level is high, while consider capital injection when the company surplus level is low. Therefore, it is not only to improve shareholder returns but also reduce the risk of bankrupt. Dickson and Waters (2004) also propose that shareholders should inject the capital in order to maintain the company's operation when the company has negative surplus. Gerber and Shiu (2006) discuss the compound Poisson model with optimal dividend, Kulenko and Schmidli (2008) discuss the classical risk model with capital injection controlled by optimal dividend Strategy; He and Zhao (2010) and Wu et al. (2011) discuss the compound binomial model with capital injection controlled by optimal dividend strategy. All of the above literature requires shareholders inject unconditionally to avoid bankruptcy. However, the purpose of capital injection is to obtain enough return, otherwise the capital injection will be ceased. Therefore, in this paper we will seek the optimal stopping time for shareholders in the process of capital injection controlled by optimal dividend strategy. Now we consider the compound binomial model in discrete time. First, the value function $V(x)$ is established. Second, via the Bellman equation satisfied by the value function $V(x)$ which maximizes the discounted value of define between dividend payment and the penalized discounted capital injection, we find the optimal stopping time $\tau*$. An optimal stopping model with capital injection in order to maximize shareholders' interests is obtained.

2 Preliminary

Let $\{X_n\}$ denote the surplus process of insurance company, i.e.

$$X_n = x + n - \sum_{k=1}^{N(n)} Y_k$$

Where $X_0 = x \in R$ is the initial reserve, the premium income per unit time is 1, $\{Y_k, k \geq 1\}$ denote the size of the claim of the kth, it is independent identically distributed random sequences, taking only positive integer values, and have the same discrete distribution with Y

$$P\,(Y = k) = \tilde{p}_k, k = 1, 2, \cdots$$

Where $\sum_{k=1}^{\infty} \tilde{p}_k = 1, EY = \mu < \infty, \mu$ is expectation of the claim amount, $\{N(n)\}$ is accumulated claim number until time n, which follows binomial distribution with parameters n, p

i.e.

$$P\left(N(n)=k\right)=C_n^k p^k (1-p)^{n-k}, k=1,2,\cdots$$

$\{N(n)\}$ and $\{Y_k, k\geq 1\}$ are mutually independent. Therefore model is known as the compound binomial model. More conclusions about the compound binomial model may refer to the document (Willmot 1993; Dickson 1994; De Vylder 1996; De Vylder and Marceau 1996; Tan and Yang 2006; Wu and Li 2006; Bao 2007; Landriault 2008).

I is a random variable which follows (0–1) distribution, and $P(I=1)=p$, let I and Y are mutually independent. $W=IY$ So

$$P\left(W=k\right)=\begin{cases}1-p & k=0\\ p\tilde{p}_k & k=1,2,\cdots\end{cases}=p_k$$

Equivalent to

$$X_n=x+n-\sum_{k=1}^{n}W_k \tag{1}$$

Where $\{W_n\}$ is an independent identically distributed random sequences, W_n and W have the same distribution.

Wu et al. (2011) consider the optimal dividend problem with capital injection

$$Z^D=(z_i)_{i=1}^{\infty},$$

$$z_i=\left\{-\min_{k=0,1,\cdots,i}\left[x+i-\sum_{k=1}^{i}(W_k+d_k)\right]\right\}\vee 0, \tag{2}$$

Where $D=(d_i)_{i=1}^{\infty}$. Equation (2) means shareholders must undertake unconditionally all possible deficits to maintain company's operation. The requirement has its own academic value, but it is not necessary for shareholders. As the deficit occurs, the shareholders' capital injection can be regarded as a new type of investment, of course they want to get enough return. Base on this fact, we should permit shareholders to choose whether injection or not when deficit occurs. Thus, in this paper, we will study the optimal stopping problem that the compound binomial model with capital injection controlled by optimal dividend $\{X_n\}$. The Bellman equation satisfied the value function $V(x)$ in literature (Wu et al. 2011).

$$V(x)=\max_{d=0,1,\cdots,x}\left\{d+\delta\left[\sum_{k=-\infty}^{1}p_k V\left(x-d+k\right)\right]\right\}\quad x\in N_0 \tag{3}$$

Then prove the optimal dividend strategy is boundary strategy. Denoted as

$$b^* = \inf\{x \geq 0, \Delta V(x) \leq 1\}.$$

3 The Bellman Equation and Optimal Stopping Strategy

3.1 Value Function

We denote the optimal strategy in literature (Wu et al. 2011) as $\pi^* = (d_i^*, z_i^*)$, then the process is given by

$$X_n = x + n - \sum_{k=1}^{n} W_k - \sum_{k=1}^{n} d_k^* + \sum_{k=1}^{n} z_k^* \tag{4}$$

value function is :

$$V(x) = V^{\pi^*}(x) = E\left[\sum_{k=0}^{\infty} \delta^k d_k^* - \beta \sum_{k=0}^{\infty} \delta^k z_k^*\right] \tag{5}$$

Where d_0^* and z_0^* are nonrandom value and satisfy the Bellman equation.

Let T denoted as a set of stopping time $\{F_n\}_{n \geq 0}$.

The strategy that start from the status of x to the stopping time $\tau \in \mathrm{T}$

$$J(x, \tau) = E\left[\sum_{k=0}^{\tau-1} \delta^k d_k^* - \beta \sum_{k=0}^{\tau-1} \delta^k z_k^*\right] \tag{6}$$

Where $\delta > 0$ is discount factor, $\beta > 1$ is penalty factor, $\beta - 1$ is denoted as cost factor such as fees. $J(x,\tau)$ can be interpreted as the discounted value of the define between dividend payment and the penalized discounted capital injection until time τ. Our objective is to find the optimal stopping time $\tau^* \in T$, at the moment the value of $J(x,\tau)$ is the biggest. So the value function is defined as follows:

$$V(x) = \sup_{\tau \in T} J(x, \tau)$$

3.2 Bellman Equation

We have to make the optimal decision at each status x in order to find out the optimal stopping strategy. We will go on whether or not when the process changes to the status. So we divided the statues space into two areas: one is continue area C, in which we should continue the work. The other area is the stopping area $\overline{C}$, in which we stop the work. Obviously, the optimal stopping strategy can be interpreted as: the process is continued until the optimal stopping time. Therefore starting from the statue x, the optimal stopping time

$$\tau^* = \inf\{t \geq 0, X_t^* \notin C\}.$$

Next we will discuss the dynamic programming principle satisfied by $V(x)$. Assumes the continue area $C \subset Z$ exists, such that

$$\tau^* = \inf\{t \geq 0, X_t^* \notin C\}$$

is the optimal stopping time, then $V(x) = J(x,\tau^*)$. For any $\tau \in T$, defined $\tilde{\tau} = \inf\{t > \tau, X_t^* \notin C\}$. According to this definition, we don't consider if there is an optimal stopping time before time τ; let the process stop when it first leave the area C after time τ. Therefore, under this requirement, we only find optimal stopping time after time τ.

So

$$\begin{aligned} V(x) &\geq E\left[\sum_{k=0}^{\tilde{\tau}-1} \delta^k d_k^* - \beta \sum_{k=0}^{\tilde{\tau}-1} \delta^k z_k^*\right] \\ &= E\left[\sum_{k=0}^{\tau-1} \delta^k d_k^* - \beta \sum_{k=0}^{\tau-1} \delta^k z_k^* + \delta^\tau \sum_{k=\tau+1}^{\tilde{\tau}-1} \delta^{(k-\tau)} d_k^* - \beta \sum_{k=\tau+1}^{\tilde{\tau}-1} \delta^{(k-\tau)} z_k^*\right] \\ &= E\left[1_{(x \geq b^*)}\left(x - b^*\right) + \sum_{k=0}^{\tau-1} \delta^k 1_{\left(X_k^* = b^*\right)} - \beta \sum_{k=0}^{\tau-1} \delta^k z_k^* + \delta^\tau V\left(X_\tau^*\right)\right] \end{aligned} \tag{7}$$

If $\tau \leq \tau^*$, then $\tilde{\tau} = \tau^*$. So

$$\begin{aligned} V(x) = J\left(x, \tau^*\right) = J\left(x, \tilde{\tau}\right) = E\Bigg[1_{(x \geq b^*)}\left(x - b^*\right) + \sum_{k=0}^{\tau} \delta^k 1_{\left(X_k^* = b^*\right)} \\ -\beta \sum_{k=0}^{\tau} \delta^k z_k^* + \delta^\tau V\left(X_\tau^*\right)\Bigg] \end{aligned} \tag{8}$$

We obtain a dynamic programming principle of the optimal stopping time combination (7) and (8).

$$V(x) = \sup_{\tau \in T} E\left[1_{(x \geq b^*)}\left(x - b^*\right) + \sum_{k=0}^{\tau-1} \delta^k 1_{\left(X_k^* = b^*\right)} - \beta \sum_{k=0}^{\tau-1} \delta^k z_k^* + \delta^\tau V\left(X_\tau^*\right)\right] \tag{9}$$

This principle will be used to get the Bellman equation satisfied by value function $V(x)$.

Theorem 1 *Value function V(x) satisfies the Bellman equation.*

$$V(x) = \left\{d_0^* - \beta z_0^* + \delta E\left[V\left(x + 1 - W - d_0^* + \beta z_0^*\right)\right]\right\} \vee 0 \qquad (10)$$

Where d_0^* and z_0^* ditto.

Proof Let τ is for any stopping time, as $\tau = 0$, we have $J(x,\tau) = 0$; as $\tau > 0$ we have:

$$J\ (x, \tau) = E\left[d_0^* + \delta E\left[\sum_{k=0}^{\tau-1} \delta^k d_{k+1}^*\right] \middle| \tau > 0\right] - \beta E\left[z_0^* + \delta E\left[\sum_{k=0}^{\tau-1} \delta^k z_{k+1}^*\right] \middle| \tau > 0\right]$$

Let $\tilde{X}_n = X_{n+1}$, $\tilde{d}_n = d_{n+1}^*$, $\tilde{z}_n = z_{n+1}^*$, $\tilde{W}_n = W_{n+1}$, $\tilde{\tau} = \tau - 1$, $\tau > 0$ we obtain the compound binomial model with capital injection controlled by dividend strategy which has the initial capital X_1

$$\tilde{X}_{n+1}^* = \tilde{X}_n + 1 - \tilde{W}_{n+1} - \tilde{d}_n + \tilde{z}_n,$$

and

$$\begin{aligned} &E\left[\sum_{k=0}^{\tau-1} d_{k+1}^* \delta^k \middle| X_1\right] - \beta E\left[\sum_{k=0}^{\tau-1} z_{k+1}^* \delta^k \middle| X_1\right] \\ &= E\left[\sum_{k=0}^{\tau-1} \tilde{d}_k \delta^k \middle| X_1\right] - \beta E\left[\sum_{k=0}^{\tau-1} \tilde{z}_k \delta^k \middle| X_1\right] \\ &\le J\ (X_1, \tilde{\tau}) \le V\ (X_1) \end{aligned}$$

Because d_0^* and z_0^* are fixed value, we have:

$$J\ (x, \tau) \le d_0^* - \beta z_0^* + \delta E\left[V\left(x + 1 - W - d_0^* + \beta z_0^*\right)\right]$$

Since τ is any stopping time, we have:

$$V(x) \le \left\{d_0^* - \beta z_0^* + \delta E\left[V\left(x + 1 - W - d_0^* + \beta z_0^*\right)\right]\right\} \vee 0.$$

The other way, let $\varepsilon > 0$, take $X_1 = x + 1 - W_1 - d_0^* + \beta z_0^*$ as initial capital. As $V(x) = \sup_{\tau \in T} J\ (x, \tau)$, there must exist stopping time $\tilde{\tau}$, such that $V\ (X_1) < J\ (X_1, \tilde{\tau}) + \varepsilon$, so

$$\begin{aligned}
& d_0^* - \beta z_0^* + \delta E\left[V\left(x+1-W-d_0^*+\beta z_0^*\right)\right] \\
& \quad = d_0^* - \beta z_0^* + \delta E\left[V\left(X_1\right)\right] \\
& \quad \le d_0^* - \beta z_0^* + \delta\left(J\left(X_1, \tilde{\tau}\right)+\varepsilon\right) \\
& \quad \le d_0^* - \beta z_0^* + \delta E\left[V\left(X_1\right)+\varepsilon\right] \\
& \quad \le V(x) + \delta\varepsilon
\end{aligned}$$

Since ε is arbitrary, we have:

$$V(x) \ge d_0^* - \beta z_0^* + \delta E\left[V\left(x+1-W-d_0^*+\beta z_0^*\right)\right]$$

Since $V(x) \ge 0$ we have:

$$V(x) \ge \left\{d_0^* - \beta z_0^* + \delta E\left[V\left(x+1-W-d_0^*+\beta z_0^*\right)\right]\right\} \vee 0$$

Thus, the theorem is proved.

Considering the optimal dividend strategy in literature (Wu et al. 2011) is the boundary strategy and the capital injection is equal to the deficit under the capital injection strategy. Therefore we give a simple expression of the Bellman equation. Let C is continue area, b^* is boundary of dividend.

If $x \in C \cap [0,b^*)$, assume C is a open set, then $\tau^* > 0$,

For any strategy

$$\begin{aligned}
V(x) &\ge E\left[\sum_{k=1}^{\tau-1} \delta^k \left(d_k - \beta z_k\right)\right] \\
&= E\left(\sum_{k=1}^{\tau-1} \delta^k \left(d_k - \beta z_k\right)\right)
\end{aligned}$$

As τ^* is optimal stopping time,

We have:

$$\begin{aligned}
V(x) &= E\left[\sum_{k=1}^{\tau^*-1} \delta^k \left(d_k^* - \beta z_k^*\right) | \tau^* > 0\right] \\
&= \delta E\left[V\left(X_1\right)\right] \vee 0 \\
&= \delta E\left[V\left(x+1-W\right)\right]
\end{aligned}$$

In conclusion

$$V(x) = \delta E\left[V\left(x+1-W\right)\right] \tag{11}$$

If $x \in C \cap [b^*,\infty)$,

$$V(x) = V\left(b^*\right) + x - b^* \tag{12}$$

If $x \in C \cap (-\infty, 0)$,

$$V(x) = V(0) + \beta x \tag{13}$$

Because of (11, 12, and 13), as $x \in C$, we have

$$\{\delta E\left[V\left(x+1-W\right)\right] - V(x)\}\, 1_{(0 \le x < b^*)} + \left[V\left(b^*\right) + \left(x - b^*\right) - V(x)\right] 1_{(x \ge b^*)} + \left[V(0) + \beta x - V(x)\right] 1_{(x<0)} = 0 \tag{14}$$

If $x \notin C$, then $\tau^* = 0$. According to the definition of value function

$$V(x) = 0, x \notin C \tag{15}$$

So

$$C = \{x, V(x) > 0\}, \overline{C} = \{x, V(x) = 0\}$$

As $x \in C \cap [0,b^*)$,

$$\delta E\left[V\left(x+1-W\right)\right] - V(x) \le 0 \tag{16}$$

As $x \in [b^*,\infty)$,

$$V(x) \ge V\left(b^*\right) + x - b^* \tag{17}$$

As $x \in (-\infty, 0)$,

$$V(x) \ge V(0) + \beta x \tag{18}$$

Because of (16, 17, and 18), for $x \in R$

$$\max_{\tau \in T} \{\delta E\left[V\left(x+1-W\right)\right] - V(x)\}\, 1_{(0 \le x < b^*)} + \left[V\left(b^*\right) + \left(x - b^*\right) - V(x)\right] 1_{(x \ge b^*)} + \left[V(0) + \beta x - V(x)\right] 1_{(x<0)} \le 0 \tag{19}$$

Because we can stop immediately, so for $x \in R$ we have

$$V(x) \ge 0 \tag{20}$$

Inequalities (19) and (20) hold at least one for each x. The same applies to (14) and (15). So for $x \in R$, we obtain the following theorem:

Theorem 2 *Value function V(x) satisfies the Bellman equation.*

$$\max\left\{\delta E\left[V\left(x+1-W\right)\right]-V(x)\right\}1_{(0\leq x<b^*)}+\left[V\left(b^*\right)+\left(x-b^*\right)-V(x)\right]1_{(x\geq b^*)} \\ +\left[V(0)+\beta x-V(x)\right]1_{(x<0)}-V(x)\Big\}=0. \quad (21)$$

3.3 Optimal Stopping Strategy

We assume that there is a continue area C in order to obtain Bellman equation, while C doesn't appear in the Bellman equation (21), but (21) shows how to distinguish between continue area and stopping area. For each status, choose to continue or stop can be given by maximized (21). Continue statue is to maximized $\delta E[V(x+1-W)]-V(x)$, that is $C=\{x\in R, V(x)>0\}$. $V(x)$ is strictly increasing, as $x<0$ and $x\in C$, we have

$$V(x)=V(0)+\beta x,$$

So $V(x)>0$ means $x>-V(0)/\beta$, so

$$C=\{x\in R, x>-V(0)/\beta\}.$$

According to the definition of optimal stopping time, we have

$$\tau^* = \inf\left\{t : X_t^* \leq -\frac{V(0)}{\beta}\right\} \quad (22)$$

In conclusion, the optimal stopping time of $\{X_t^*\}$ is the time that less than or equal to $-V(0)/\beta$ for the first time. At this moment, the process stays in stopping area, that is $V(x)=0$.

From above the discussion, $V(0)/\beta$ is the biggest deficit that shareholders are willing to bear. As the deficit excess $V(0)/\beta$, shareholders' capital injection will not get enough return at this time. So until time $\tau*$, $J(x,\tau*)$ achieve maximum value.

Theorem 3 *Let a non-negative increasing function v(x) is a solution of the Bellman equation* (21), *and* $\tau^* = \inf\left\{t : X_t^* \leq -\frac{v(0)}{\beta}\right\}$, *then* $v(x)=V(x)=J(x,\tau*)$, *that is* $\tau*$ *is the optimal stopping time.*

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Study on Value Effect of Fund Management Based on GRE 3D Balanced Perspective: A Case Study of Listed Companies in Construction Industry and Real Estate Industry

Li Wang and Gui-wen Liu

Abstract Fund management is an important part of enterprise finance management and is closely related to enterprise management strategy and financial management objective. This paper set listed companies in construction industry and real estate industry on stock markets of Shanghai and Shenzhen in China as the study sample, constructed an analytical framework of fund management effect based on 3D balanced perspective of EVA, growth and risk, investigated the fund management effect of domestic construction and real estate enterprises, and obtained useful information about economic development in construction industry and real estate industry. The methodology involves understanding the determinants of enterprises' value creation through: (1) an extensive literature review; (2) collection of financial and managing data from listed companies; and (3) analysis of data to identify value effect of fund management that are more effective in real estate enterprises. Regression analysis reveals that the fund management effects are poor both in construction enterprises and real estate enterprises: there is significant negative correlation between value creation efficiency of enterprise and the enterprise scale, the resource allocation is unreasonable between short and long term assets, and economies of scale cannot be reflected. In path analysis on sub-samples, the previously significant correlation coefficients have become insignificant, showing that administrators of construction enterprises and real estate enterprises have not controlled the EVA, growth and risk well and the balance theory of income and risk has not been reflected. Contrastive analysis presents that fund and resource allocation and management level of construction enterprises and real estate enterprises is low in China at present, and fund management level of these two typical capital intensive industries should be improved urgently. Findings from this study could provide helpful guidelines for construction and real estate companies in developing countries. Recommendations for achieving future value creation are also provided.

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1 Introduction

Under marketing conditions, fund management is the key factor for an enterprise to succeed. There are many bankruptcy cases caused by poor fund management. Almost all world-famous transnational corporations will mention their advanced fund management concepts when talking about their successful experience. In recent years, with rapid development of real estate industry and gradual openness of construction market, competition on global construction market has been intensified, especially in China, whether in terms of the overall construction market or its various sub-industries, China is in a state of excessive competition. Most construction enterprises in China have high yield and low interest, they lack enough funds to increase their overall competitiveness, and they can barely maintain survival. This has severely hindered sound development of the entire industry and increased the competitive gap with international construction enterprises. On the other hand, real estate enterprise is a typical example of capital intensive industry, meanwhile, it is also the industry that has the greatest influence on construction industry. In recent years, under the influence of regulatory policies for real estate market, there appears a severe problem in fund management. Generally speaking, both construction industry and real estate industry are typical capital intensive industries, they are under deep influence of macro-control policy, and have characteristics of huge investment, high risk, long period, long supply chain, and strong regionalism, so they can refer to each other in fund management. Regulatory policies for real estate market have been gradually deepened, and the present state of competition in China cannot be improved in a short time. Therefore, under such background, to ceaselessly increase allocation efficiency of enterprise resources, especially to increase value creation ability of enterprises via improvement of fund management level will be an important channel for China's construction enterprises and real estate enterprises to adapt to the market, make a breakthrough, and win development in the fierce competition.

2 Previous Studies

With gradual intensification of market competition, enterprises have paid more and more attention to the management efficiency of various resources and the input-output benefit. Fund management that occupies an important position in business management activities is a hot issue in the present academic circles. Most studies on fund management are based on working capital, while few studies have mentioned monetary fund that has the strongest liquidity and highest risk in production and management activities. Working capital, also known as operating capital, contains both broad sense and narrow sense. Working capital in a broad sense, also known as gross working capital, refers to funds of an enterprise' investment in current assets, covering cash, negotiable securities, accounts receivable, inventory, etc. Working capital in a narrow sense refers to the balance between current assets and current liabilities of an enterprise at a certain time point, this is working capital in a general meaning, and is also expression for working capital from the accounting perspective, it means the net amount of current assets and current liabilities. In addition, from the angle of enterprise operation and management, by fully analyzing insufficiency of the existing definition of working capital, WANG Zhuquan and SUN Ying defined working capital as all capitals used in daily conversion during normal business operation of enterprises by starting from explanation of joint concept statement for business concept as well as its enlightenment for new statement presentation (Wang et al. 2011). The research contents mainly concentrate on optimum current ratio, optimum holding ratio and management efficiency for working capital. Early performance evaluation for working capital management was often conducted by setting current assets turnover ratio (or turnover period) as independent variable and traditional profitability index as dependent variable, and thus relation between turnover efficiency of various current assets (inventory turnover ratio, turnover of account receivable, and turnover ratio of account payable) and the current operating performance could be measured. In 1976, Hampton C. Hager proposed the concept of cash conversion cycle (CCC) for the first time, he suggested that cash conversion cycle should be used to measure liquidity of working capital and obtained that cash conversion cycle had negative correlation with operating performance (Hager 1976). In 1980, Richard and Laughlin made a study on cash conversion cycle and defined cash conversion cycle as the net time interval between expenditure for procurement and final withdrawal of product distribution, which means cash conversion cycle = inventory turnover period + turnover period of account receivable − turnover period of account receivable, they suggested that this index should be used to reflect the full view of working capital management (Richards and Laughlin 1980). In 1989, John J. Hampton and Cecilia L. Wagner expanded the contents of working capital management: they associated storage allocation of working capital with corresponding capital sources, and investigated the effect of working capital from the aspects of profitability and risk (Hampton and Wager 1989). In 2003, Martin Gosman and Trish Kelly proposed the index of "excess days" by aiming at working capital management efficiency of American retail enterprises, which means difference between days of inventory sales and days of paying off account receivable formed by purchase, commodity sold in retail enterprises often involves cash sale, so the influence of account receivable can be neglected, therefore, "excess days" is actually equal to the previously mentioned "cash conversion cycle" (Gesman and Keby 2003). In the same year, Marc Deloof studied time series data of 1,009 non-financial enterprises in Belgium and obtained the same conclusion with Hampton C. Hager (Deloof 2003). Two Spanish scholars have collected a panel of 8,872 small to medium-sized enterprises covering the period 1996–2002, concluded that managers can create value by reducing their inventories and the number of days for which their accounts are outstanding, especially shortening the cash conversion cycle (Garcia-Teruel and Martinez-Solano 2007), this supports Hampton C. Hager's view. Scholars who also hold such view include H. H. Shin, L. Soenen (1998), H. Nobanee, M. Ajjar (2009), A. E. Danuletiu et al. (2010), Karaduman et al. (2011), M. Mwalla (2012). Besides, some scholars detailed working capital and studied monetary fund or cash with the strongest liquidity and highest risk. For instance, ZHANG Xianhua analyzed the influence of transaction cost of collecting external funds, investment opportunity, cycle period of monetary fund, and ownership structure on monetary fund holdings via transaction cost model and agency cost theory, and he obtained that internal governance structure of the company had great influence on monetary fund holdings, dividend policy, and capital structure decision (Zhang et al. 2004), ZHANG Feng analyzed the relation between monetary fund holdings and corporate governance structure from the aspects of ownership concentration, manager's ownership, board composition, and the protection degree for external investor, and gained the perspective through empirical analysis that over-investment might exist in monetary fund holdings among Chinese listed companies, by setting panel data of listed companies in manufacturing industry on stock markets of Shanghai and Shenzhen as the sample, GU Yupu discovered through Pearson correlation analysis that current assets ratio had no significant correlation with profitability of the company (ROA, ROE), it had negative correlation with cash flow caused by business activities, current liabilities ratio had negative correlation with profitability of the company, and cash conversion cycle had negative correlation with profitability of the company and cash flow caused by business activities (Gu 2006), in order to make it convenient for analysis, he removed sample companies with negative cash conversion cycle. In fact, negative cash conversion cycle means that fund required in daily operation of the company is advance payment from others, showing that working capital management efficiency of the company is high, this is beneficial to increase of corporate performance, so it is improper to remove these representative sample companies. ZHANG Ruiwen and WANG Ping considered that there was significant correlation between cash adequacy and corporate performance expressed by ROA in manufacturing industry (Zhang and Wang 2007), HAN Shijun analyzed relation between use condition of monetary fund and enterprise value among listed companies in Beijing City via typical case study method, and suggested that we should pay more attention to monetary fund storage and usage amount to increase enterprise value (Han 2011).

In measurement for operating performance, most scholars have adopted traditional financial indexes, such as ROI, ROA, operating profit ratio, operating revenue, increase rate of business revenue, EPS, and PE ratio. Diversification has been presented in studies on performance in academic circles since 1991 when economic value added (EVA) was raised by American scholar, Stewart (1991). In specific, firm performance was studied via Tobin's Q, MVA, EVA, and share price, or correlation analysis was conducted between them and traditional financial indexes. These scholars all acknowledged the interpretation of Stern Stewart & Co. for EVA. That is to say, EVA is a single index based on value that can evaluate development strategy, operating performance and internal incentive mechanism of the company, it is better than other indexes like EPS and ROI. Therefore, a set of financial management system, decision-making mechanism and compensation system based on EVA theory has prevailed in major companies around the world (Stewart 1994). Domestic scholars also started to study the EVA. More specifically, such scholars include Dengshi Huang, Yingfoon Chow (2004), Yede Huang, Yupu Gu (2004), Hong li and Deming Zhang (Li et al. 2006), but their research is restricted to manufacturing industry and financial industry. In 2009, British scholars suggested that current researchers should encourage the construction industry to operate on the basis of EVA (Leiringer et al. 2009). Subsequently, State-owned Assets Supervision and Administration Commission of the State Council pointed out in No. 22 decree that *Interim Measures for Assessment of the Operational Performance of Persons in Charge of Central Enterprises* was going to be implemented from 1 Jan. 2010, later state-owned construction and real estate enterprises of China started to adopt EVA performance evaluation system, but the academic circle has not paid enough attention to construction and real estate industry and there is a lack of empirical studies on fund management and value creation effect of EVA. Domestic research conclusions show that EVA is better than EPS (Biddle et al. 1997), ROA, EPA and EPE (Li et al. 2006) in describing firm performance, it is better than ROE, BVPS and MBR (Jiang 2011) in explaining variation of share price, EVA has higher information content and explanatory ability for market value added (MVA), but it cannot fully explain market value, and still needs other financial indexes to interpret market value (Wang 2010). Document retrieval shows that domestic studies are mainly launched in structural management of working capital, management policies and evaluation indexes, there are empirical researches about the relation between efficiency of working capital management and earning power, but they are quite simple in selection of research samples, index design and research methods. In foreign countries, relatively complex and meticulous empirical studies have been done on the basis of normative analysis, and there are both similarities and differences in research conclusions. The existing empirical studies have the following four characteristics: Firstly, indexes used to evaluate situations of working capital management are mainly fund turnover period and its components based on time dimension, indexes that reflect situations of working capital management are incomplete: they have not brought usage, storage and turnover period of working capital into a complete evaluation system and have not reflected importance of monetary fund management, which will influence accuracy of evaluation for fund management effect to some degree and go against business decisions. Secondly, indexes of measuring operating performance or value creation of the enterprise (ROA, operating profit ratio and operating revenues) are relatively backward, which will affect fitting degree of the model to some extent. Thirdly, scale and industry factors are major control variables that most scholars will consider. Fourthly, in terms of research methods, descriptive statistics, correlation analysis and regression analysis are often adopted in foreign countries, while Chinese scholars always use contrastive analysis or simple descriptive statistics and correlation analysis. There is a lack of systematic path analysis, so it is difficult to explain causal effect and the influence degree among all variables.

3 Research Design and Variable Selection

3.1 Theory Construction

Through comparison between domestic and overseas researches, this paper mainly studied the relations between situations of fund management and value creation ability of construction and real estate enterprises. Fund here refers to monetary fund including cash, bank deposit and other monetary funds, it is the most active fund in production and operation activities and is also the asset with the strongest liquidity and highest risk. Fund management can be further divided into that of usage, storage and turnover period. Situations of fund management include three parts: capital flow (also known as fund usage amount), capital storage (also known as fund adequacy), and fund turnover period (also known as fund turnover rate). Fund management effect of construction industry and real estate industry was revealed through study on relation between fund management level and value creation ability. Meanwhile, in order to make fund management better serve financial management objectives of enterprises-improvement in sustainable profitability (Zhu 2002), the author constructs GRE (growth, risk and EVA) 3D balanced path analysis chart, to study relation among situations of fund management, growth ability and anti-risk capacity, and further analyze relation between situations of fund management and value creation ability. Firstly, value effect of fund management has reflected proportional relation between input and output. The smaller the amount of monetary fund during a certain period is, the greater the profit is, and the better the managing efficiency of monetary fund is. Secondly, fund management can furthest pursue benefit and guarantee sustainable development of the enterprise only by controlling the risk within a bearable scope. On the other hand, during growth and expansion of the enterprise, both insufficiency and overabundance of working capital should be avoided. Therefore, fund management should be devoted to creating value for the enterprise under the guidance of balance theory of value, growth and risk. This paper tries to obtain the overall situation of fund management in the current construction industry and real estate industry through study on listed construction enterprises and real estate enterprises, and discussed the optimum level of fund and resource allocation among capital intensive enterprises. Fund turnover period (or fund turnover rate) directly affects fund adequacy (that is effective capital storage) of the enterprise, and funds remaining in the enterprises cannot create value directly, so this paper will not give independent consideration to the current capital storage and its turnover efficiency. Instead, this paper adopted their product as index of measuring fund adequacy (that is effective capital storage) of the enterprise, besides, it also analyzes the influence of fund usage amount and fund adequacy on value creation effect of the enterprise.

3.2 Variable Selection

The independent variable X_1, also known as fund usage, reflects the use condition of working capital during the current year, it is equal to the sum of cash outflow in business activities, cash outflow in investment activities, and cash outflow in financial activities. The independent variable X_2, also known as fund adequacy, reflects effective capital storage owned by the enterprise, it is equal to X_a*X_4, where X_a is total capital storage that is equal to the amount of monetary fund in balance sheet, X_4 is turnover rate of monetary fund, equal to 365/X_5. X_5 (also known as turnover rate of monetary fund) is used to reflect the length of fund turnover time, bank deposit and other monetary funds which possess circulation and payment functions equivalent to cash, so actually they are equal to cash, therefore, turnover period of monetary fund is equal to cash conversion cycle.

In terms of dependent variables, previous studies often adopt a certain financial index to reflect the enterprise' operating performance and the most common indexes cover operating profit ratio, ROE and ROA. However, such selections can only reflect a single aspect of the operating performance that is profitability and it has neglected marketability, operation capacity, growth ability and solvency. Based on achievements of previous researches on EVA, this paper adopts EVA to measure value creation ability of the enterprise. According to Stewart's definition, EVA is the difference between NOPAT (Net Operating Profit after Tax) and COTC (Cost of Total Capital), which is $EVA = NOPAT - WACC \times TC$ in formula, where NOPAT is the operating profit after tax before the accounting subjects of financing cost and noncash amortization are deducted, TC is the cash input after depreciation is subtracted, and it is often equal to the sum of equity capital and debt that bears interest, or the result of subtracting current liabilities that do not bear interests from the total capital, WACC indicates weighted average cost of capital. During the process of calculating EVA, NOPAT and TC have to be adjusted. Adjustment for EVA mainly covers over 100 terms like deferred income tax, inventory falling price reserves, R&D capitalization value and goodwill amortization. However, over 10 important adjustment terms are involved in practical investigation for specific enterprises. The key to gaining the calculation formula for EVA is to determine the accounting subjects that should be adjusted. This paper obtains the adjusted value of EVA on the basis study of CSMAR, and the calculation process is as follows:

$$EVA = NOPAT - WACC \times TC$$

NOPAT = (operating profit + financial expense + depreciation of fixed assets, depreciation of oil and gas assets, and depreciation of productive biological assets + amortization of intangible assets + amortization of long-term deferred expenses) * (1 – T)

Weighted average cost of capital (WACC) refers to the weighted average by calculating cost of debt capital and cost of equity capital according to their proportions, that is:

$$\mathrm{WACC} = \left(\frac{\mathrm{KD}}{\mathrm{KE} + \mathrm{KD}}\right) \times (1 - T) \times K_d + \left(\frac{\mathrm{KE}}{\mathrm{KE} + \mathrm{KD}}\right) \times K_e$$

In the formula, KE represents equity capital, KD means debt capital, K_d indicates cost rate of debt capital, K_e refers to cost rate of equity capital, T is income tax rate, equal to the result by dividing income tax by total profit in profit statement.

Capital asset pricing model (CAPM) is adopted to calculate cost rate of equity capital (K_e), that is:

$$K_e = R_f + \beta \times \left(R_m - R_f\right)$$

In the formula, R_f is riskless rate of return, and the mean value 3.25 % of the time deposit rate in one year issued by People's Bank of China in 2011 is adopted for its calculation, β is the risk factor of risk assets, and it is calculated according to equity derivative regression model and taken from CSMAR, R_m is annual rate of return of the market, $(R_m - R_f)$ is the risk premium of market portfolio and reflects premium of the entire securities market to riskless rate of return, at present, the market risk premium of 4 % in China issued by authorities is adopted.

The mean value 3.25 % of the time deposit rate in 1 year issued by People's Bank of China in 2011 is adopted to calculate cost rate of debt capital (K_d). Relevant data show that liability method of Chinese listed companies is different from that of foreign companies that will issue abundant short-term notice and long-term bonds. Liabilities of Chinese listed companies mainly cover bank loans, and current liability occupies more than 90 % of total liabilities, therefore, it is reasonable to determine cost rate of debt capital according to loan interest rate of the bank.

Calculation method for invested capital is as follows: TC = general capital + liability with interest − non-operating investment. In which capital stock = total owners' equity + minority equity + various reserve balances, liability with interest = short-term borrowing + long-term liability of one year + total long-term liability, non-operating investment = monetary fund + construction in process (engineering material).

3.3 Research Hypothesis

Only by controlling the risk within a bearable scope, can fund management create value to the largest degree and guarantee sustainable development of the enterprise. Therefore, this paper constructs two latent variables which are GROWTH and RISK, in which GROWTH refers to growth rate of operating profit and reflects the influence of fund management on the speed of firm growth from the longitudinal

Table 1 Definitions of all variables

Variables	Properties	Definitions	Data sources
EVA	Dependent variable	EVA = NOPAT-WACC × TC (millions RMB)	Author' calculation
X_1	Independent variable	X_1 means the usage of funds, X_1 = cash outflows from operating activities + cash outflows from investing activities + cash outflows from financing activities (millions RMB)	Cash flow statement
X_2	Independent variable	X_2 means the effective storage of funds, $X_2 = X_3 \times X_4$ (millions RMB)	Author' calculation
GROWTH	Lurking variable	Maximum increase rate of sales without issuing additional new stocks under the current operating efficiency and financial policy (%)	CSMAR
RISK	Lurking variable	Price fluctuation of the enterprise stock on the overall stock market is used to measure risk degree of the enterprise	CSMAR
SCALE	Control variable	SCALE is defined by fixed assets-net value (millions RMB)	Balance sheet
TYPE	Control variable	1 stands for construction and 2 stands for real estate enterprises	CSRC
X_3	Special variable	X_3 means the amount of funds from balance sheet (millions RMB)	Balance sheet
X_4	Special variable	X_4 means the turnover frequency of funds, $X_4 = 365/X_5$	Calculation
X_5	Special variable	X_5 means the turnover period of funds, X_5 = No. of days inventories + No. of days accounts receivables − No. of days accounts payables + No. of days accounts prepaid − No. of days advances from customers	Balance sheet and calculation

angel, RISK indicates overall risk of the enterprise, it is equal to β coefficient, and reflects the influence of fund management on enterprise risk from the horizontal angle (see Table 1).

In order to analyze the influence of independent variables on value creation ability in detail, this paper adopted path analysis method to construct causal model diagram (that is path analysis chart) (see Fig. 1). Path analysis not only pays attention to correlation among variables, but also studies causal relationship among

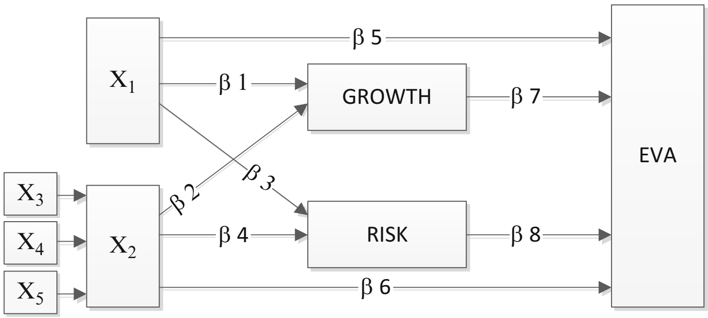
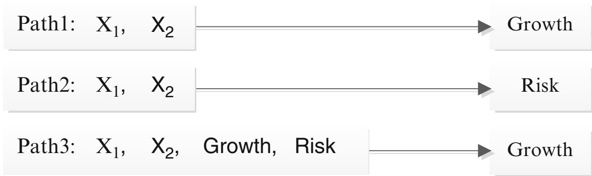


Fig. 1 Path analysis diagram

Fig. 2 Three paths representations



variables. Path analysis includes three steps: firstly, construct causal model diagram, and make arrows in the figure point at explained variables which are criterion variables; secondly, divide causal model diagram into several multiple regression models, and work out path coefficient via proper regression methods (enter method is often adopted); thirdly, analyze the model and gain conclusions (Wu 2010). Three paths (see Fig. 2) and three hypotheses constructed in this paper are as follows:

Hypothesis 1: Without considering the influence of other factors, there is correlation among fund usage amount, fund adequacy and growth ability

Hypothesis 2: Without considering the influence of other factors, there is correlation among fund usage amount, fund adequacy and anti-risk capability

Hypothesis 3: Without considering the influence of other factors, there is correlation among fund usage amount, fund adequacy, growth ability, anti-risk capability and value creation ability

4 Empirical Analysis

4.1 Samples

This paper analyzes all listed companies in construction and real estate industry on Shanghai and Shenzhen stock market (CSRC's industry classification standard). In order to eliminate influence of variation data, ST companies and companies that have lost data were eliminated, so finally 37 construction enterprises and 82 real

Table 2 Descriptive statistical analysis

	N	Minimum	Maximum	Mean	Std. deviation
EVA	119	−8.00	28,452.00	1,617.73	4,055.60
X1	119	179.00	533,130.00	2 5,972.92	86,485.76
X2	119	−2,114,251.00	583,726.00	−11,958.13	2.09E5
GROWTH	119	−12.24	54.34	10.57	9.39
RISK	119	50.73	145.33	97.94	15.82
SCALE	119	2.00	38,507.00	1,431.45	5,294.31
X3	119	24.00	88,157.00	4,509.81	13,448.82
X4	119	−28.06	19.00	0.7477	5.20
X5	119	−456.00	5,583.00	1,262.9832	1,194.75
N Valid	119				
Missing	0				

estate enterprises were selected as samples. Data adopted in this study are mainly from CNINFO, cnlist.com and website of National Bureau of Statistics and People's Bank of China, in which various initial financial indexes of the enterprise were obtained from China Stock Market Accounting Research (CSMAR), the missing parts were obtained from CNINFO, and relevant indexes used to calculate EVA were taken from website of National Bureau of Statistics and People's Bank of China.

4.2 Descriptive Statistics of Different Variables

Through descriptive statistics of different variables, it is clearly that: there are great differences among sample companies in major variables like fund usage amount, fund adequacy and fund turnover rate, showing that fund management level is different among domestic listed companies in construction industry and real estate industry (see Table 2).

4.3 Correlation Analysis

In order to conduct preliminary analysis for correlation among different variables, a series of correlation tests is applied and the following conclusions is obtained: firstly, it is different from the conventional thoughts about effect of working capital management, there is no significant linear correlation between EVA and Growth; secondly, there is weak negative correlation between EVA and fund adequacy (X_2); thirdly, EVA has significant negative correlation with anti-risk capability, and has significant positive correlation with fund usage amount (X_2) and SCALE (see Table 3).

Table 3 Correlation analysis

		EVA	X1	X2	GROWTH	RISK
EVA	Pearson correlation					
	Sig. (2-tailed)					
X1	Pearson correlation	0.947**				
	Sig. (2-tailed)	0.000				
X2	Pearson correlation	−0.162	−0.239**			
	Sig. (2-tailed)	0.079	0.009			
GROWTH	Pearson correlation	0.087	0.014	−0.024		
	Sig. (2-tailed)	0.347	0.877	0.793		
RISK	Pearson correlation	−0.475**	−0.430**	0.022	−0.007	
	Sig. (2-tailed)	0.000	0.000	0.815	0.936	
SCALE	Pearson correlation	0.768**	0.901**	−0.466**	−0.041	−0.344**
	Sig. (2-tailed)	0.000	0.000	0.000	0.661	0.000

Notes: "**" indicates significant correlation at the level of 0.01 (2-tailed)

Table 4 Regression analysis

		Unstd. coefficient		Std. coefficient			Collinearity Statistics	
Model		B	Std. error	Beta	t	Sig.	Tolerance	VIF
1	(Constant)	1,885.948	649.416		2.904	0.004		
	X1	0.065	0.003	1.378	22.674	0.000	0.134	7.472
	X2	−0.002	0.001	−0.077	−2.687	0.008	0.599	1.671
	GROWTH	18.725	9.742	0.043	1.922	0.057	0.970	1.030
	RISK	−16.149	6.352	−0.063	−2.542	0.012	0.805	1.243
	SCALE	−0.405	0.050	−0.529	−8.150	0.000	0.117	8.532

4.4 Regression Analysis

Based on correlation analysis, regression analysis is applied. The result suggests: $R = 0.972$, $R^2 = 0.944$, $F = 382.248$, sig. = 0.000, the unexplained amount of variation is 5.6 %, and coefficient of alienation is $\sqrt{1-R^2} = \sqrt{1-0.944} = \sqrt{0.056} = 0.237$. DW = 1.667, VIFmax = 8.532, the value of DW is around 2, and the maximum value of VIF is less than 10, showing that there is no autocorrelation in error terms of this model, and there is no severe multicollinearity in this regression model. In addition, $F = 382.248$ and sig. $= 0.000 < 0.05$, all variables have passed significance testing at the level of 5 % except for GROWTH (see Table 4), showing that the established regression model is effective and the regression effect is significant. The regression equation is as follows:

$$\begin{aligned} \mathrm{EVA} = {} & 1885.948 + 0.065\mathrm{X}_2 - 0.002\mathrm{X}_2 + 18.725\mathrm{GROWTH} \\ & -16.149\mathrm{RISK} - 0.405\mathrm{SCALE} \end{aligned}$$

4.5 Path Analysis of Sub-samples

Causal model framework in path analysis includes direct effect and indirect effect. In direct effect, if path coefficient becomes significant, it means that there is direct causal relationship between two variables, in indirect effect, if path coefficient becomes significant, it means that there is indirect causal relationship between two variables, what's notable is that the influence path of indirect effect is diversified, and not every mediating variable has significant influence. Besides, in order to compensate insufficiency of the existing documents, this paper analyzes path coefficients of construction industry samples and real estate industry samples and tested whether they are significant via enter method on the basis of regression analysis, residual coefficient is further estimated and coefficient of alienation is obtained (coefficient of alienation is also known as residual variation and it is used to measure the variation part where independent variables as causes cannot explain dependent variables). Enter method is the so-called multiple regression, its main idea is to make all predictor variables that are to enter multiple regressions enter the regression equation at the same time, and then judge whether the influence is significant according to size and probability value of each t value. Path coefficients in which various explanatory variables have influence on explained variables should be found out according to standardized regression coefficients in the regression model. In order to prevent autocorrelation and severe multicollinearity in multiple regression models, 3 multiple regression models should be evaluated before path coefficients are calculated, so as to guarantee effectiveness of multiple regressions. The following empirical findings can be gained in SPSS17.0:

4.5.1 The First Multiple Regression

Research result of the first multiple regression in construction industry presents: $R = 0.221$, $R^2 = 0.049$, $F = 0.550$ and sig. = 0.652, showing that fund usage amount, fund adequacy, and enterprise scale of construction industry can explain 4.9 % of the variation of growth ability, the unexplained amount of variation is 80.5 %, and the coefficient of alienation is $\surd(1 - R\hat{}2) = \surd(1 - 0.049) = \surd 0.951 = 0.975$. DW = 2.468, and VIFmax = 9.128. However, F = 0.550, and sig. = 0.652 > 0.05, showing that the established regression model is ineffective and the regression effect is insignificant.

In real estate industry: $R = 0.234$, $R^2 = 0.055$, $F = 1.532$ and sig. = 0.213, convincing that fund usage amount, fund adequacy and enterprise scale can explain 5.5 % variation of growth ability, the unaccountable amount of variation is 94.5 %, and the coefficient of alienation is $\surd(1 - R\hat{}2) = \surd(1 - 0.055) = \surd 0.945 = 0.972$. DW = 2.185 and VIFmax = 1.712. However, F = 1.532 and sig. = 0.213 > 0.05, indicating that the established regression model is ineffective and the regression effect is insignificant.

4.5.2 The Second Multiple Regression

Research result of the second multiple regression in construction industry shows: $R = 0.633$, $R^2 = 0.400$, $F = 7.119$ and sig. = 0.001, convincing that fund usage amount, fund adequacy and enterprise scale can explain 5.5 % variation of growth ability, the unaccountable amount of variation is 94.5 %, and the coefficient of alienation is $\sqrt{}(1 - R\hat{}2) = \sqrt{}(1 - 0.400) = \sqrt{}0.600 = 0.775$. DW = 1.366 and VIFmax = 9.128. DW is around 2 and VIFmax is less than 10, that is to say there is neither correlation nor serious multicollinearity. Moreover, $F = 1.532$ and sig. = 0.001 < 0.05, it indicates that the established regression model is effective and the regression effect is significant.

In real estate industry: $R = 0.323$, $R^2 = 0.104$, $F = 3.066$ and sig. = 0.033, convincing that fund usage amount, fund adequacy and enterprise scale can explain 10.4 % variation of growth ability, the unaccountable amount of variation is 89.6 %, and the coefficient of alienation is $\sqrt{}(1 - R\hat{}2) = \sqrt{}(1 - 0.104) = \sqrt{}0.896 = 0.947$. DW = 2.182 and VIFmax = 1.712. DW is around 2 and VIFmax is less than 10, that is to say there is neither correlation nor serious multicollinearity. Moreover, $F = 3.066$ and sig. = 0.033 < 0.05, it indicates that the established regression model is effective and the regression effect is significant.

4.5.3 The Third Multiple Regression

Research result of the third multiple regression in construction industry shows: $R = 0.991$, $R^2 = 0.982$, $F = 318.337$ and sig. = 0.000, convincing that fund usage amount, fund adequacy and enterprise scale can explain 98.2 % variation of growth ability, the unaccountable amount of variation is 1.8 %, and the coefficient of alienation is $\sqrt{}(1 - R\hat{}2) = \sqrt{}(1 - 0.982) = \sqrt{}0.018 = 0.134$. DW = 2.575 and VIFmax = 9.638, DW is around 2 and VIFmax is less than 10, that is to say there is neither correlation nor serious multicollinearity. Moreover, $F = 318.337$ and sig. = 0.000 < 0.05, it indicates that the established regression model is effective and the regression effect is significant.

In real estate industry: $R = 0.986$, $R^2 = 0.972$, $F = 540.980$ and sig. = 0.000, convincing that fund usage amount, fund adequacy and enterprise scale can explain 97.2 % variation of growth ability, the unaccountable amount of variation is 2.8 %, and the coefficient of alienation is $\sqrt{}(1 - R\hat{}2) = \sqrt{}(1 - 0.972) = \sqrt{}0.028 = 0.167$. DW = 1.791 and VIFmax = 1.847. DW is around 2 and VIFmax is less than 10, that is to say there is neither correlation nor serious multicollinearity. Moreover, $R^2 = 0.972$, $F = 540.980$ and sig. = 0.000, it indicates that the established regression model is effective and the regression effect is significant.

It can be gained by comparing three regression models in construction industry and real estate industry that the influence of fund usage amount and fund adequacy on value creation ability presents great difference among different samples (see Table 5). Especially in the third multiple regression model, there is great difference in significance of path coefficients (see Table 6).

Table 5 The total effects of path coefficients in construction and real estate industry

The effect of X on Y	Indirect path 1	Indirect path 2	Direct path	Total effect
Construction industry:X_1 on Y	$\beta_1 * \beta_7 = 0.011$	$\beta_3 * \beta_8 = 0.011$	$\beta_5 = 1.288$	1.31
Construction industry:X_2 on Y	$\beta_2 * \beta_7 = -0.005$	$\beta_4 * \beta_8 = 0.002$	$\beta_6 = -0.038$	−0.042
Real estate industry: X_1 on Y	$\beta_1 * \beta_7 = 0.009$	$\beta_3 * \beta_8 = -0.013$	$\beta_5 = 0.951$	0.947
Real estate industry: X_2 on Y	$\beta_2 * \beta_7 = 0.007$	$\beta_4 * \beta_8 = -0.002$	$\beta_6 = 0.013$	0.018

Table 6 Comparisons of path coefficients in different samples

Construction-sample				Real estate-sample			
Path code	Std. coefficient	T-value	sig.	Path code	Std. coefficient	T-value	sig.
β_1	0.455	0.960	0.344	β_1	0.169	1.180	0.242
β_2	−0.218	−0.959	0.345	β_2	0.137	0.990	0.325
β_3	−0.665	−1.768	0.087	β_3	−0.249	−1.786	0.078
β_4	−0.099	−0.552	0.585	β_4	0.047	0.345	0.731
β_5	1.288	18.016	0.000	β_5	0.951	36.894	0.000
β_6	−0.038	−1.127	0.268	β_6	0.013	0.545	0.588
β_7	0.024	0.816	0.421	β_7	0.051	2.524	0.014
β_8	−0.016	−0.428	0.672	β_8	−0.050	−2.373	0.020

It's easy to know by combining with the regression Research results that small sample size is the main reason of such difference. In samples of construction industry, there is no significant correlation between fund adequacy and value creation ability, only fund usage amount has significant positive correlation with value creation ability. In real estate industry samples, fund adequacy has no significant and direct correlation with value creation ability of the enterprise, but it affects value creation ability of the enterprise through its influence on anti-risk capability and growth ability of the enterprise, besides, fund usage amount has significant and direct correlation with value creation ability and indirectly affects value creation ability through anti-risk capability (see Fig. 3).

5 Conclusions

To sum up, we can get the following conclusions. (1) Value creation ability of listed companies in domestic construction industry and real estate industry has significant and direct correlation with fund usage amount and fund adequacy, and indirect correlation also exists, showing that the more the fund usage amount is, the stronger the value creation ability of the enterprise is. (2) Regression analysis shows that both fund usage amount and fund adequacy have significant influence on growth ability, but such significance is inconsistent with conclusions of path analysis for sub-samples, showing that growth of construction industry and real estate industry has not reached sustainable development. (3) Regression analysis suggests that both fund usage amount and fund adequacy have significant influence on financial

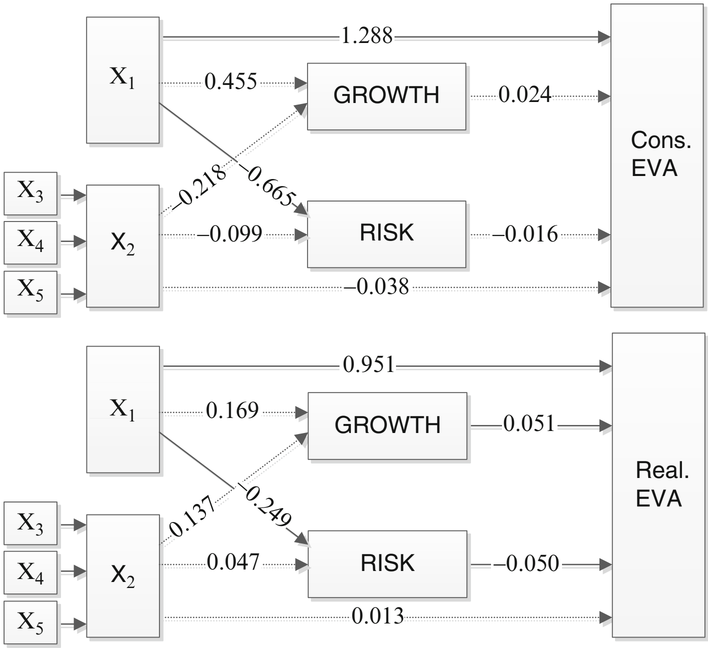


Fig. 3 Illustrations and comparisons of path coefficients

risk, but in samples of construction industry, there is no significant correlation between value creation ability and anti-risk capability of the enterprise, which is inconsistent with regression analysis and correlation Research results, this shows that risk management level of domestic construction industry lags behind when compared with real estate industry and value creation effectiveness of construction enterprises has not reached a balance between income and risk. (4) In regression analysis and path analysis, all control variables (enterprise scale) have negative correlation with value creation ability, showing that in the current construction industry and real estate industry, there exist diseconomies of scale, short and long term resource allocation is unreasonable, GRE principle is not followed well during operation and management process, and the effect of fund management should be improved as soon as possible.

According to the above research results of regression analysis and path analysis, sub-samples of construction industry and real estate industry have different performances during the study. The main reasons include particularity of construction enterprises, besides, the sample size also has some influence. In specific, listed companies in construction industry are much fewer than that in real estate industry in China, after eliminating ST companies and companies that have lost data, the sample size has become smaller. This might affect the research results to some extent.

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Part VIII
Management Sciences – Human Resources Development and Management

On the Social Root of Economic Contrast Between the South China and the North China in Terms of Human Resources Management

A Comparative Study of Labor Groups Between Jilin and Developed Provinces

Xiao-di Wang

Abstract Through a comprehensive analysis of the major economic indicators of Jilin and developed provinces, this thesis reveals the striking gap of the economic development between the north China and the south China, and points out on the theoretical basis of human resources management that it is human resources that act as the major social root leading to such difference—the result of different qualities of various groups of laborers under market economy. On this basis, combined with the situation of economic development of Jilin province, this thesis proposes strategies for promoting the qualities of laborers, thus further fills up the theory of "human resources as the first resources", settling solid mass and social foundation for the construction of an innovative country.

Keywords Economic difference • Human resources management • Social root

1 Introduction

Historical materialism considers that the unification of productivity and relation of production during the production of material goods form the social mode of production i.e. the obtaining method for people to get their necessary material goods. It is also the ultimate power of all social development and innovation (Afuah 1998). Any change or development of social formation is firstly caused by the change of productivity, which accordingly demands the change of means of

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production to fit into it, thus giving rise to the innovation of production mode and leading to the substitution of social system finally (Asheim 1999). As such, we can perceive that the change of the means of production at first is the original driving force during the development of human society.

In these three elements of productivity, human is the most important. Because the laborers with productive experience and working skills keep playing a leading and crucial role in the process of production. They can awaken productive material from death dream, hence change its "value in use" from possibility to reality. During the fast development of new technologies of the world, each new breakthrough in the fields of science and technology is a new leap for the development of social productivity (Boekema et al. 2000). With regard to the spiritual power and initiative of laborers, there has already been a comprehensive analysis in Capital by Karl Marx. He points out that nature itself has not created any wealth. "it is the product of human industry, as well, materialized intelligence . . . The development of permanent assets manifest to what extent can the general social knowledge be changed into direct productivity and then to what extent can the social production itself be controlled and reconstructed by knowledge" (Marx 2007). Here, Marx divides the productivity into two distinct forms. One is direct productivity, the other is indirect productivity. Both forms are possessed by science and technology simultaneously. They are indirect productivity when they have not yet transformed and materialized from the general condition into laborer skills and specific working tools; while science and technology once incarnated as skills of laborers and materialized as specific instruments of labor, and also find their way to the process of production, it becomes direct productivity (Redding 2009). That is to say, science and technology are not an independent factor in productivity, and cannot transform into direct productivity unless it connects closely with the three elements of productivity (Wejnert 2008). How fast science and technology can transform the relation with productivity from indirectness to directness relies on the zeal of the working people to develop their efficiency and creativity (Souder et al. 2008).

There are lots of reasons for the striking contrast in economic development between the south and the north in China, such as geographical position, climate condition, starting point in development and historical process, etc. But the critical reason is the contrast of the qualities of laborers between the north and the south (Healey and Ilbery 1999).

In this paper, "labor group" has a relatively wide conceptual category referring to those who undertake various productive activities, scientific technology and social practice. This group includes not only employed workers under the planned economy but also various migrant workers under market economy, and laid-off and retired workers who are re-employed, in addition, individual and the self-employed laborers who cannot be re-employed.

2 Comparison and Analysis of the General Economic Situation of Developed Provinces and Jilin Province

According to the latest statistics from The World Yearbook 2012, GDP of Jilin province reached RMB 469.3 billion yuan that year, while the per capita GDP was 17,211 yuan, ranking the 22nd among 31 provinces of China, from which we can see the big gap between Jilin province and developed provinces in terms of economic development (Report on the work of the government of Jilin Province in 2012). Here we will make a more elaborate analysis of it with private economy and county economy as examples.

2.1 The Big Gap Between Private Economy of Jilin Province and That of Developed Provincial Regions in Terms of Economic Development

The private economy is an important component of socialist market economy, so analysis of the development of private economy can help us get quite an accurate understanding of the significant differences in economic development between northern and southern regions in market economy environment.

In 2012 the total private economy in Jiangsu Province has leapt to a new level, breaking a trillion yuan. The added value of the province's private economy amounted to 1.29087 trillion yuan. More than half of the GDP was contributed by private economy, taking up 50.5 %. Private economy has become an important component of the whole province' economy. 2012 witnessed the continuous quick growth of the provincial economy. The growth rate of GDP soared to 14.8 %, while that of private economy was 15.2, 0.4 % higher. Private economy is making increasingly more contribution to economic development, with a rate of contribution 5.2 % higher than the year before which was 46.3 %, boosting the province's economic growth by 7.6 percentage points, thus became a major driving force for the fast development of economy.

In recent years, the distribution of industries of the private economy in Jilin province tends to keep a balance. Private economy is gradually entering into more business areas. However, data show the big gap with that of Jiangsu province. In 2010, private economy took 10 % of the industrial economy in Jilin. Its backward development had become a shackle that restrained the economic development of Jilin province. In spite of its development to some degree in 2012, taking up 38.8 % of GDP, there was still a gap of 11.7 % with 50.5 % in Jiangsu province (Report on the work of the government of Jilin Province from 2007). What is more, problems do not limit to this. At present, private economy of Jilin province still mainly concentrates on the secondary industry and traditional tertiary industry, such as transportation, wholesale and retail trade, catering service and so on. Industries that are vital to the survival of national economy and national security, as well as finance, post and tele-communication, public facility service in tertiary industry, are mostly remaining controlled by the monopoly of state-public ownership economy. There is obvious discrimination among private enterprises and state-owned enterprises, foreign-funded enterprises in terms of market access. Private economy meets barriers of capital, technology and many other factors, in addition, the limitation of market and policy barriers. In some area, the room for its growth is restricted to a substantial extent.

2.2 The Big Gap Between County Economy of Jilin Province and That of Developed Provincial Regions in Terms of Relative Indicators

In 2012, per capita GDP of county regions was 6,770 yuan, while per capita GDP nationwide was 9,057 yuan, in addition, that of the 100 most developed counties reached 21,000 yuan. Per capita GDP of county regions accounts for 74.8 % of per capita GDP nationwide. Per capita GDP of the 100 most developed counties was 15.1 times that of those with the lowest.

If well-off level (per capita GDP) is 800 US dollars, that is 6,500 yuan, the result will be: by the end of 2010, per capita GDP of county regions would have reached the well-off level. But average does not equal to majority. The number of counties with per capita GDP lower than the level approached 64 % of the total number of counties nationwide. As to the case of Jilin province, per capita GDP of counties was 7,836 yuan, a bit higher that the national average, but ranked 13th because of its weak competitiveness of county regional economy.

Another report from Jinlin in 2012 shows that GDP of county economy of this province was 3,705 million yuan, and the local revenue was 98 million yuan. The two indicators were both lower than the national average, ranging the 13th and 16th respectively.

County regional economy is a basic part with comparatively complete function and variety of industries in the whole national economy. Vigorous county regional economy has become the basis and driving force for the fast development of national economy. The quick growth of national center developed provinces greatly owes to the continuous growth of the vitality and power of suburban county regional economy. From the process of the development of county regional economy, it is obviously seen that developed provinces are doing better than Jilin province in terms of size, speed and efficiency.

At present, county regional economy of Zhejiang province takes up 60 % of the total GDP of this province. As early as 1998, Zhejiang provincial committee and government put forward the new aim of basic realization of the modernization of agriculture and the countryside, and further proposed a three step strategic deployment with county as the basic implementation unit. Under such new strategic instruction, Zhejiang county regional economy moved forward to a new phase with the construction of modernization as the center work. This demonstrated some new highlights that deserved attention and created much new experience.

County regional economy in Zhejiang province first realized the transition to market economy. Its market economic level was obviously higher than that of large and medium cities. So to speak, the reform of market based economy in every area all starts from county regional economy, and then spreads to large and medium cities after it has taken practical effect. Thanks to these market oriented reforms, Zhejiang county regional economy went first in the transition from planned economy to market economy, The extent of market-oriented economy is much higher than that of large and medium cities. Market mechanism has already been functioning as a basic force that regulates the distribution of resources and productive factors for county regional economy.

Hunchun city in Yanbian Autonomous Prefecture does best in the development of county regional economy of Jilin province. Its prominence is due to the geographical priority to a great extent. It is truly an exception of our province. Other county regional economies lag far behind those of developed provinces. Presently, because of barriers of policy, capital, project, technology and the like, we are confronted with many difficulties and problems in developing county regional economy.

Based on the comparative analysis of the situation of the private economy and the county regional economy from the north to the south, we can see a problem: some counties and cities of Jilin are developing well in the two aspects because of favorable geographical factor instead of policy; whereas southern areas depend on the support of policies. Policies are made by people, and the initiative of people are playing a very important role in social economic development. This is indeed the social root that cannot be ignored for the big gap between the northern and the southern economic development. It is also a primary topic to be solved urgently for northern provincial regions including Jilin. In other words, Jilin outshines others due to geographical position while southern regions' full bloom relies on policies. It is the very reason for the big gap between the north and the south, and also a significant issue that should get our profound consideration.

3 Recommendation

The achievement of economic activities is wealth, whose source is continuously booming social productive forces. While the prerequisite for advanced social productivity is the population resource of high mental and cultural qualities. Population resource is the product of nature and the crystallization of culture. Economic activities and social developments are eventually reflected in some kind of cultural sate, which in turn advance social development in the form of people's quality, ability, self-cultivation, consciousness, belief, morality and mental outlook. Therefore, the ideas of representing developed productivity, representing the essential benefit of the mass and representing the direction of advanced culture proposed by Jiang Zemin are interdependent and inseparable. So, to improve the mental and cultural qualities of the population resource with the labor as the main body should be the main task of China's current social development.

3.1 Intensifying Reform and Improving the Cultural Quality of Industrial Workers

As an important component of urban population, the quality of the vast majority industrial workers determines the overall cultural quality of the city population. Reasons for this conclusion are very obvious. Firstly, among the employed population the industrial workers have absolute advantage in quantity; secondly, they serve in the main fields of economic construction, so the level of their quality may determines the development of economic society of our province. That is to say, the modernization of our province cannot do without the main industrial forces of high quality, otherwise, even the best system will become castles in the air. To participate in the international competition, industrial workers of high quality are needed, otherwise, even the most advanced technology and inventions cannot be turned into competitive products. Japan's success is a plain example. However, with the rolling in of business opportunities after China's Reform and Opening, there are indications that the quality of our province's industrial workers are showing a downward trend. This is not in line with the strategic objective of our province's economy development. So, to improve the quality of the industrial forces have become extremely necessary for advancing our province's economy to a new level.

Developed countries emphasize the lifelong education for talents, instead of once and for all. This approach has been proved correct by practice. The cultivation of industrial workers should also be life-long education, and on-job-training is a good to solve the problem. It is necessary to set up training centers for industrial talents, organize training on a regular basis, and help updating the knowledge of in-service personnel. Only in that way will the industrial forces accommodate themselves to the needs of science and technology and society development, and also in that way will our province's economy develop with staying power.

With the rapid development of modern science and technology in terms of socialization and integration, compound talents are increasingly important. Creative and versatile talents among the great industrial forces are those who can work creatively and explore the unknown areas. They should be of high cultural level, of perfect knowledge structure, of initiative thoughts and of sensitive judge to the new tendency of knowledge. They should be the vanguard of the industrial forces. Personnel department should, through such means as setting the typical model, guide the more concentrated professional department and large and medium sized state-owned enterprises to establish bases for education and training, encourage capable enterprises to adopt flexible and diverse approach to continuing education, identify and select talented people to accept more comprehensive and systematic education. So we can both help them realize and command new theories, new information and new skills concerning related professions, and update knowledge structure. As a result, the professional and technical level of the general industrial forces can be advanced to a new level.

We should create good opportunities for business personnel and human resources development by attracting more business talents to enter the market along with the use of modern technology, then new mechanisms for employment and career will be formed. Firstly, following the improving personnel agency system in the non-publics, the system can be extended to all types of enterprises; it will provide different services in response to different needs in various enterprises of different owner-ship for personnel agency; services will be perfected after changing the management by identity to the management by post. Secondly, we should collect and record information about entrepreneurial talents with post-transferring, according to the practice of enterprise reform. Consequently, we can provide the society with information about talents supply and demand on a regular basis, by establishing data bases of corporate surpluses and the recruitment information. Lastly, we should make the intermediary services provided by the talent market available to all types of talents. What is more, we should also convene recruitment fair for pillar industries, key enterprises and non-public enterprises, in addition to running regular job fairs, to guarantee flexible brain circulation, so that the overall quality of industrial workers will be enhanced in the dynamic atmosphere of market economy.

3.2 *Providing Essential Vocational Education to the Migrant Workers*

Farmers possess dual identities of both farmers and city "workers". Their cultural qualities, technical competence and moral standards determine the rise or fall and success or failure of the new countryside-construction; they may determine the quality and effectiveness of their work also. Without much education, the farmers are lacking in work skills, cultural quality and technology transferring ratio. There are not enough farmers-in-the-new-time with good understanding of skills and scientific farming; there are not enough young farmers with a good command of science and technology and management; there are not enough farmer-enterprisers and talents with high-tech. Obviously, these are not in line with adjusting the agricultural structure, expanding key industries, increasing farmers' income and qualifying farmers to work in cities.

Education and training for farmers are essential, to which all levels of governments and leaders should attach great importance. They should be integrated into the Agricultural Restructuring and regarded as the Hope Project invigorating the rural economy and helping farmers become rich. The agricultural department should be prepared to farmer training program, including the content, ways, places and expenses. Trainings can be organized in bases of agricultural schools and agro-technical extension sectors. To stimulate farmers to study and utilize science, education and training for farmers should be regarded as public welfare, and certain amounts of funds should be guaranteed by various measures. Furthermore, we should strengthen the publicity, making it clear the importance of educational training to farmers. Then they will take initiatives to accept the trainings. Hereby, education and training for farmers will be institutionalized and standardized.

Peasants in cities are usually family members or relatives. Their social circle is limited to members of their own group. Though in cities, they do not have the opportunity of full interaction with the city citizens. So they become an interstitial group of the city in the new era. It is important work to support the education of peasant workers, especially in terms of their mental health. Coming from remote and underdeveloped countryside to cities, they take a sense of self-abasement, feeling that they are inferior to city people in all respects: they are poor in money, narrow in horizon, low in status, living a life not as good as city people. All these thoughts are fettering them, making them look down upon themselves, and overcautious in doing anything. They are careful not to disturb or offend the city citizens who they think are superior. As a result, their closed living environment leads to a phenomenon of "isolated island" in psychology. So stress should be put on the education in terms of peasant workers' integration into city and on psychological instruction for them. It is the responsibility for the peasant worker community to form a good psychological atmosphere, to help them improve self-respect, self-confidence and to provide them with proper guide, so that they can get correct self-recognition.

In history, peasants are short of knowledge of law and the ability of self-protection. Particularly when their rights are violated, and they do not know how to get judicial protection. No way to appeal, so to speak. Therefore, our work of the first period is to perfect labor laws, setting up concrete rules for the protection of peasant workers' rights, so as to make law a true weapon to defend their rights and interests. However, specific laws in form are not enough. To raise their legal quality, work must start from strengthen their sense of self-protection, spreading common sense of law with reference of their own experiences. The community will choose some judicial workers to establish a legal publicity group that takes charge of legal publicity and education touring around within the community, helping peasant workers to understand their labor rights and how to protect their interests. In this way, peasant workers will develop a legal sense of self-protection, get a clear understanding of their legal rights, and be able to defend themselves with the weapon of law at critical moment. It is a great leap for peasant workers to protect themselves by law. As well, it is of vital importance for the improvement of the integral quality of our social citizens.

Peasant workers are a group among "peasants", who are most liberated in mind, most active in thinking, excellent in intelligence, distinguished in creativity. At the same time, they are fresh troops of "industrial workers" who are young, energetic, daring to think and do, skilled at communication to the highest degree. At present, only 13.6 % of countryside labor force has accepted training of professional skills. Vocational education of peasant workers concerns the stability of social order and the harmonious development of the whole society. Research data shows that in recent years, with urban enterprises attaching increasingly more importance to skilled workers and intermediate and advanced technicians, the proportion of peasant workers that go to cities for jobs with orientation of direction and place has reached beyond 90 %. To make it easier for peasant workers' livelihood, it is necessary to help them master a skill through vocational education.

Professional skill education for peasant workers is a complex educational project. The main purpose of the career education and training is not to store knowledge, but more importantly to meet the urgent current need of basic skills and to solve the problem of unfamiliarity with technical operation. In view of the practical need of peasant workers' work, vocational education and training for them should take the characteristics of short time and quick effect. They are taught what they need. The content of training must live up to the need of their practical work and agree with the development of peasant workers and the present reality conditions, highlighting practicality and pertinence. Professional skill education for peasant workers should really achieve the purpose of helping them to master a skill in a short time.

Vocational training for peasant workers should take intensive and systematic teaching content and flexible teaching form, keeping concerned with their practical rights, avoiding charging high fees. At the end of short-term training, the training institution should issue certificate of qualification in accordance with their technical competence. Vocational skill education to a great extent can meet peasant workers need of professional skills for present work and for the transferring of employment. What is worth being mentioned is that the education includes hardware construction and the coordination and integration of various community resources. A certain amount of investment is required. But it is not realistic to solely depend on the community. So financial support from higher authorities is needed. Central finance should establish special fund for the education of peasant worker community, setting up a money collection system of multi-levels from the center to regions, so as to make sure that the fund for peasant workers' education is available in time as needed.

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Study on the Relationship Between Human Capital Management and Agricultural Enterprise Performance—Based on Different Marketing Strategy

Li-li Wang, Yue-wu Wang, and Wen-ming Sun

Abstract This paper takes listed agricultural companies from 2007 to 2011 in our country as sample and analyzes the existing problems of human capital investment and the influence on enterprise performance by using independent sample t test and regression analysis. Then we discuss the relationship between human capital investment, enterprise performance and marketing strategy. The study found that human capital investment can promote agricultural enterprise performance. And that will be more sensitive under the influence of positive marketing strategy.

Keywords Agricultural enterprise • Human capital • Marketing strategy • Performance

1 Introduction

Knowledge economy is a new economic form. Human capital has become the source and ultimate power of new economic growth. Actually, the competition of a company is the competition of the human resource. Human capital investment is very important to enterprise's human capital and competitive ability. So how to invest human capital reasonably becoming the rational choice for countries, regions and occupations, the agriculture is included.

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2 Hypothesis

2.1 Human Capital and Agricultural Enterprise Performance

Human capital investment has gradually became the hot topic in the study of Chinese and western scholars since its creation by Schurz. Human capital is the knowledge and skills embodied in people's memory, qualifications, experience, etc., it is a major cause of modern economic growth (Schurz 1971). The formation and development of human capital investment theory also show in the process of economic modernization, people's knowledge about human capital and its role is deepening. In the related agricultural study about human capital investment, Zhang Yonglin et al. (2002) studied the economies of scale and income of technology and human capital in the process of agricultural resources flow and agglomeration, and analyzed the extrusion process, the mechanism and consequences, at last he regarded rural education development and the improvement of population quality as the fundamental basis for the development of agriculture in our country. Lu Yunhe and Huang Jindong (2002) made a deep discussion from regular education, health care, skills training, migration, etc., with qualitative and quantitative analysis, thus constructing the general framework of human capital investment of agriculture and making a beneficial discussion. Jiang Jun (2009) researched human capital investment behavior in the agricultural public human capital investment system, and study agricultural enterprise human capital from the macroeconomic level. Currently, the particular researches about agricultural enterprise human capital and its performance are few. Because labor intensive and family management are the main characteristics of the agricultural enterprise, and they lack human capital investment. Relative to physical capital, human capital is more creative, in the era of knowledge economy, human capital investment efficiency is higher than material capital, so the current human capital investment situation means that it has a great potential impact on agricultural enterprise performance. Based on the above analysis, we put forward assumption 1: Agricultural enterprises strengthen human capital investment can effectively improve the performance.

2.2 Human Capital's Impact on Agriculture Enterprise Performance Under Different Marketing Strategy

Marketing strategy, namely the enterprise's ideas and plan of a certain period in the modern marketing concept, the aim is to achieve its business goals and improve marketing ability is an important symbol of modern agriculture (Liu Yulai 2004). In our country, the agricultural enterprises are still small and short of market-oriented marketing concept at present, this situation faced in the process of marketing seriously affects their competitiveness. Actually fundamentally marketing ability is the enterprise survival and development necessary condition, so the agriculture need increase investment in marketing in order to improve the business performance and competitiveness of China's agriculture. In the recent 30 years study of American enterprises, Er Fang (2012) found that enterprise's investments on R&D and advertising have significant positive effects on its performance when financially squeezed. Frankenberger (2006) thought if the advertising media selection was wrong, marketing information of the core values if design could not pass good products, and even advertising or promotion of improper execution time and higher marketing spending may have little effect. Therefore scholars for marketing expenses will improve of damage the company's performance does not form a unified opinion. Whether marketing fee can improve or damage the company's performance actually be influenced by the different views about the nature of marketing costs (Tang Yuejun and Song Yuanyang 2012). Some scholars think that marketing costs is a long-term investment of enterprise and marketing investment in long-term contributes to the formation of enterprise intangible assets Danaher and Rust (1996). Of course, it need enterprise's long-term investment. In the knowledge-based agriculture, human capital, knowledge and information technology become the main strategic resource for the development of agricultural enterprise. So agricultural enterprises in the whole process of marketing, including market research, target market development, marketing channel choice and so on a series of decision-making process, always need the marketing knowledge and the creativity and initiative of human capital. So the interaction of marketing ability and human capital is likely to be effective to improve the performance and competitiveness of agricultural enterprises when increase the marketing costs. Another part of the researchers tend to view marketing as a business cost and argue that excessive marketing costs could lead to potential pressure for the company cash flow and damage the company's performance. With the improvement of living standards, people buy products not only for the table, but also for the pursuit of consumer grade and the meet of material and spiritual double pursuit. So implementing positive marketing strategy (e.g. the brand marketing), agricultural enterprise can affect its performance significantly. In the meantime, employees and managers can improve the quality of human capital in the "learn by doing" (Zheng Wenzhi 2009), thus further affect its profitability. Based on the above analysis, we put forward hypothesis 2: human capital investment can have a more sensitive effect on agricultural enterprise performance under positive marketing strategy.

3 Research Design

Research design of this paper includes two parts, firstly, compare human capital investment between agricultural enterprises and other industries and analyze human capital investment present situation. Secondly, build model 1 and 2 to study hypothesis 1 and 2.

Table 1 Human capital investment of agricultural enterprise (million yuan)

Statistic	2007	2008	2009	2010	2011
Mean	7,450	9,320	9,790	13,100	15,900
Maximum	36,300	45,860	50,900	169,000	210,600
Minimum	267	389	78	76	14
Standard deviation	8.52	10.76	11.23	25.84	31.9
N	32	33	36	47	47

Table 2 The mean difference in different industries

	Transportation-agriculture		Mining-agriculture		Communication-agriculture		Manufacture-agriculture	
	t	df	t	df	t	df	t	df
2004	3.47**	96	1.33	33	1.19*	110	6.57**	83
2007	3.36**	104	1.97*	44	1.053	126	5.84**	86
2011	3.83**	129	2.2*	54	0.691	243	2.74**	64

Note: t means statistic, df is freedom, *, ** show that the mean difference are obviously different from 0 on the level of 10 %, 5 %

3.1 The Basic Fact of Agriculture Enterprise Human Capital Investment in China: A Descriptive Study

Table 1 shows the present situation of human capital investment from 2007 to 2011 (Cash paid to employee and for employee as the measurement variable) (Wu Jiyu 2006). We can see that the mean is rising year by year, from 74.5 million in 2007 to 159 million in 2011, the number is double, but the overall level is not high. The maximum and minimum values of human capital investment change obviously. Standard deviation increased over time, and it suggests that the degree of differentiation of human capital investment increases year by year.

3.2 The Mean Difference t-Test of Human Capital Investment in Different Listed Companies of Different Industries

Based on comparable principle, we choose transportation, mining, communication technology and manufacture as the objects to be compared, discussed the human capital investment. Implement Independent Samples *T*-test for small sample, unknown range by SPSS 17.0.

From Table 2, we know their mean differences are different between agriculture and other industries. In general, the difference is obvious except for the communication technology. The explanation is that the information technology industry is an

Table 3 The main research variables' mean standard deviation and Pearson correlation coefficient

	Mean	1	2	3	4	5	6	7
Roa	0.22	1						
Roe	0.14	0.78**	1					
OIR	2.12	0.27**	0.11	1				
TQ	2.56	0.3**	0.22*	0.11	1			
Hc	$5.4E6$	0.29**	0.21*	0.26**	0.1	1		
S-ra	0.05	0.23**	0.16	0.12	0.2*	0.9*	1	
Cs-ra	−0.00	0.10	0.08	0.28**	−0.2	0.2*	−0.3*	1

Note: **,* mean the outcome is obviously different from 0 in the level of 1 % and 5 % respectively

emerging service industry, the number of employees involved is less, so the total cost is limited. The results also show that industry has a great influence on human capital investment. The human capital investment is greater than listed agriculture company in most industries, it shows that they lack talent incentives in particular and cannot keep real talents, so increasing the human capital investment is likely to improve its performance.

3.3 *The Human Capital's Impact on Agricultural Enterprise Performance*

3.3.1 The Data Source

In view of the performance impact of marketing costs for agricultural enterprises is lagging, this paper selected the panel data of sample companies with 5 years from 2007 to 2011. In order to reduce the error, (1) we remove the research samples which lack of data. (2) Remove abnormal samples whose operating expense is negative (Chen Liming and Yang Zhirui 2003). In the end, we obtain 126 observations, including 29 of 2008, 31 of 2009, 29 of 2010, 37 of 2011.

From Table 3, we found that (1) the average OIR of listed agricultural companies is 2.12, standard deviation is 5.5139, they are different in different enterprises. (2) The average human capital investment is 5,427.34 million yuan, it is low. (3) The average operating rate is 0.05, the percentage is small, there is no significant difference among various enterprises. (4) The correlation coefficient between the explanatory variable and control variables is nor large, the largest number is 0.9 between S-rate and Hc, the others are less than 0.8, so we can say that there is no serious multicollinearity among variables.

3.3.2 Research Model

1. Human capital investment and performance of listed agricultural companies

$$\mathrm{CP}_{i,t} = \beta_0 + \beta_1\ Hc_{i,t-1} + \beta_c\ Control_{i,t} + \varepsilon_{i,t}. \tag{1}$$

Model 1 is used to test the hypothesis 1, aims at revealing the specific relationship between human capital investment and listed agricultural companies performance. $\mathrm{CP}_{\mathrm{i,t}}$ is short of company performance which can be measured by ROA, ROE, OIR and TQ. In monetary form, human capital is the cost of improving population quality and skill, such spending will bring owner satisfy feeling of income. So in this paper, we choose the cash paid to employees and for employees as the measurement variable, namely the Hc. In order to avoid the effect of endogenous at the same time, we choose the last data. Control variables are asset-liability ratio, scale, the last income growth and return on net assets, ε is the error term.

2. Human capital influence on firm performance—based on different styles of marketing strategy.

$$\begin{aligned}\mathrm{CP}_{i,t} = {} & \beta_0 + \beta_1\ Hc_{i,t-1} + \beta_2\ MBR_{i,t-1} + \beta_3\ Hc_{i,t-1} \times MBR_{i,t-1} \\ & + \beta_c\ Control_{i,t} + \varepsilon_{i,t}\end{aligned}$$

Test hypothesis 2, the dependent variable $\mathrm{CP}_{\mathrm{i,t}}$ is the same as the model 1, the independent variables Hc, MBR represent the human capital investment and the agricultural enterprise marketing strategy style respectively. Sales cost, human capital investment and company's performance may be endogenous, so we choose issue of data to broke the mutual causality (Tang Yuejun and Song Yuanyang 2012). Sales expense basically covers the major marketing activities, and its data can be obtained, so we use sales expense to measure marketing strategy, the more the sales cost is, the more positive of marketing strategy, conversely the more conservative. $\mathrm{MBR}_{\mathrm{i,t-1}}$ can be measured by sales cost rate and rate of change of sales cost of $\mathrm{t}-1$ issue. The control variables are the same as model 1. The variable name and meaning are as follows (Table 4).

4 Discussion

In this paper, firstly, using model 1 to test human capital influence on agricultural business performance, reoccupy test model 2 under different marketing strategy, the human capital influence on agricultural corporate performance. In order to guarantee the reliability of the results. The dependent variable is represented by ROA, ROE, OIR, and TQ, specific as follows (Table 5):

Table 4 The variable name and meaning

The code	The variable name	The variable meaning
ROA	Return on total assets	Net income/total assets
ROE	Return on equity	Net income/net worth
OIR	Operating income growth rate	Revenues of T period minus $t-1$ period
TQ	Tobin Q value	(The value of equity + market value of net debt)/final total assets
$Hc_{i,t-1}$	The human capital of the previous period	
$S\text{-}rate_{it-1}$	Listed companies selling rate of the previous period	Cost of sales/revenue
$CS\text{-}rate_{t-1}$	Listed company sales cost rate of change of the previous period	Sales cost rate of T period minus $t-1$ period
Lev	Asset-liability ratio of listed companies	Total debt/total assets
Size	The scale of listed company	The natural logarithm of total assets
OIR_{t-1}	The listed company operating income growth rate of the previous period	
ROE_{t-1}	Return on net assets of previous	

Regression analysis: (1) Human capital investment has a positive and significant impact on ROA, ROE, OIR of agricultural enterprises, also the TQ of enterprise but the effect is not obvious. The main reason is that the enterprise TQ includes equity market capitalization and debt market, the value of the stock is easily affected by external factors, but has limited sensitivity to internal factors such as human capital investment, it confirmed assumption 1. Therefore, in order to effectively improve the performance of agricultural enterprises, we should increase investment in human capital. (2) The higher the LEV, the easier its performance decline, reason is that agricultural enterprise is a traditional labor-intensive enterprise with limited funds. So they cannot obtain the benefit of the leverage effect by improving the financial leverage, but easy to increase the financial risk, therefore they should be cautious with agricultural enterprises financial leverage. (3) The bigger the agricultural enterprise scale is, more possible to effectively improve the performance, it shows that agricultural enterprises have economies of scale, the larger the size, the stronger

Table 5 Human capital investment and performance of listed agricultural companies

	ROA	ROE	OIR	TQ
α	−0.726***	−1.995***	14.604	8.395**
Hc	4.8E-10***	1.29E-9***	2.91E-8**	3.2E-9
Lev	−0.201***	−0.624***	3.034*	−2.278***
Size	0.038***	0.105***	0.761*	−0.212
OIR_{t-1}	0.001	−0.002	0.208*	0.01
ROE_{t-1}	0.002	0.004	−0.285	−0.003
Year	Control	Control	Control	Control
R^2	0.378	0.29	0.136	0.429
Adj-R^2	0.336	0.242	0.077	0.389
F	8.9	5.982	2.3	10.97
N	126	126	126	126

Note: *, **, *** respectively in 10, 5 and 1 % significance level

Table 6 Human capital investment's impact on its performance under different marketing strategy

	ROA		ROE	
α	−0.772***	−0.729***	−1.985***	−1.983***
Hc	4.E-10***		1.2E-9*	
$S\text{-rate}_{t-1}$	0.433***		0.001	
$CS\text{-rate}_{t-1}$	0.779***		0.756	
$Hc_{t-1} \times Srate_{t-1}$		2.8E-9***		7.4E-9**
$Hc_{t-1} \times CS\text{-rate}_{t-1}$		4.8E-9***		1.03E-8*
Lev	−0.204***	−0.203***	−0.63***	−0.625***
Size	0.038***	0.039***	0.105***	0.106***
OIR_{t-1}	0.001	0.001	−0.02	−0.002
ROE_{t-1}	0.002	0.001	0.004	0.004
Year	Control	Control	Control	Control
R^2	0.388	0.412	0.294	0.296
Adj-R^2	0.341	0.366	0.24	0.242
F	8.175	9.016	5.379	5.43
N	126	126	126	126

Note: *, **, *** respectively in 10, 5 and 1 % significance level

the ability to resist risk, profit ability is stronger, so it should expand the scale of the enterprise. (4) The issue of OIR, ROE of agricultural enterprises has no significant impact on profit of this issue (Table 6).

Analysis: (1) Marketing expense of agricultural enterprise has a positive role on promoting performance. When profitability measured by ROA the promoting effect on the level of 1 % is more significant, overall a positive marketing strategy can promote agricultural enterprise performance. (2) In model expressed by two different indicators of performance, the interaction coefficients of human capital and the marketing strategy are (2.8E-9***, 4.8E-9***), (7.4E-9**, 1.03E-8*), the fit of the model are 0.366, 0.242,the coefficient of human capital are 4.0E-10***, 1.2E-9*, the fit of the model are 0.341, 0.24, overall under the interaction, not only it can improve the fit of the model, but also the more active marketing strategy, human capital investment can influence performance effectively under active marketing strategy, hypothesis 2 is confirmed. (3) Effect of agricultural enterprises size and level on the performance is similar to the above.

5 Conclusion

In this paper, based on the listed Chinese agricultural enterprise financial data from 2007 to 2011, using independent sample t test, correlation analysis and regression analysis methods, the results found that: (1) Relative to other industries, agricultural enterprise human capital investment is obviously insufficient, in the current condition of low human capital incentive, strengthening the human capital investment can significantly promote the performance. (2) In knowledge economy era, agricultural enterprises should adopt a marketing strategy which is more positive and keep pace with the times. Then they can effectively improve their profitability, and under the effect of this, the human capital investment's influence on the performance is more sensitive.

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A Cluster Analysis of the Research of Governmental Staff's Competency

Lu Ma and Da-you Du

Abstract Cluster analysis is a kind of multivariate statistical analysis method that processes the problem of quantitative classification research. It is designed to detect hidden groups or clusters in a set of objects which are described by numerical, linguistic or structural data. The concept of competency is introduced in China in the late 1990s. It gets much research achievements in the field of enterprise management. However, it is relatively less research of the governmental staff's competency, the first literature about the research of the governmental staff's competency was published in 2004. Through the method of cluster analysis, we get three hot spots of the governmental staff's competency: the introduction of competency concept into the assessment of the governmental staff's ability, the basic unit governmental staff's competency research, and the governmental leader's competency research, they are also the frontier areas of the research.

Keywords Cluster analysis • Cluster • Competency • Governmental staff's competency

1 Introduction

Cluster is defined as a mathematical technique that designed for revealing classification structure in the data. In other words, the main purpose of clustering is to find out the classification structure of the data, and to arrange objects into groups according to their similarities or relationships without losing significant information about the data (Budayan et al. 2009). Cluster analysis is a kind of multivariate statistical analysis method that processes the problem of quantitative classification research.

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The basic idea of the cluster analysis is that each object has some similarities at the same kind, and the similarities will be much less at the different kinds, then multiple observation indexes that can find out statistics which are used to measure the similarities between variables. According to some kind of cluster method, all the variables can be divided into different class (Wei Li et al. 2012). It is designed to detect hidden groups or clusters in a set of objects which are described by numerical, linguistic or structural data (Bock 1996). It is a common method in various areas of research such as computer science, bio-information, marketing, manufacturing, organization and psychology (Gelbard et al. 2009).

In the 1970s the concept of competency was put forward, and competency concept was introduced in China in the late 1990s. It gets much research achievements in the field of enterprise management. However, it is relatively less research of the governmental staff's competency, the first literature about the research of the governmental staff's competency was published in 2004. Then the governmental staff's competency research literature is on the increase. The governmental staff's competency research can play a positive role of promoting the efficiency of personnel recruitment, assessment, training, and providing theoretical basis for the governmental human resource management system reformation.

2 Literature Review

Li and Zhang (2008) based on 624 master's degree theses in information science in the database of CNKI, clustered the high frequency co-words, to study the inner relationship between the high frequency co-words, and to explore hot spots of the information science research of these master degree theses (Li Changling and Zhang Xuemei 2008). Cao Ling et al. (2010) clustered the competitive intelligence research in China, and analyzed the hot spot in the field of the competitive intelligence research (Cao Ling et al. 2010). Zhang and Tian (2011) revealed the feasibility and effectiveness of the digital library research with the help of analyzing the high frequency cited literatures in 1995–2009 on CNKI (Zhang Li and Tian Lina 2011). Zhang Yu et al. (2011) based on CNKI database from 1997 to 2010 journal articles that related to the field of data mining, used SPSS cluster analysis, factor analysis and multidimensional scaling analysis to analyze the domestic research status of data mining (Zhang Yu et al. 2011). Wu (2011) pointed out that using the book circulation data to study the reading tendency is a kind of scientific, objective method of data mining (Wu Zhiqiang 2011). Library automation system saves a large amount of historical data that uses cluster analysis which is one of the means of data mining can reveal reading tendency of persons that hidden behind the data. Wu Jingming and Wu Lin 2011 studied the structure of the relationship between high frequency co-words, explored higher education master and Ph.D. theses topic that combined with frequency analysis and cluster analysis of the 16 universities that can award the doctor's degree, to summarize research focus of the last 10 years in China. Xu and Guo (2011) explored 8 main frontiers that studied authors cited the same literature of the contemporary international technology innovation research with the methods network analysis and cluster analysis (Xu Zhenliang and Guo Xiaochuan 2011). Wang Lanfu et al. (2012) analyzed high frequency keywords of the 4,537 Ph.D. degree theses of management science and engineering that can reflect the research hot spots, studied the inner relationship between the high frequency keywords to present the tendency of the research (Wang et al. 2012).

Wei and Yu (2007) expanded global managers' competencies in order to meet the development of the modern business challenges with the method of fuzzy DEMATEL (Wei Wenwu and Yu Tinglee 2007). (Bots et al. 2009) tested the competency of management accountants which was issued by the Accountants-in-business section of the International Federation of Accountants for Management Accounting Practice and Practitioners report in 2002. They presented the result that showed the same sequence of competencies during their careers, and gave suggestion for the continuing education programs. Zoogah and Peng (2011) explored the answer that determines the performances of strategic alliance managers, they investigated the behavior of the managers and found some competencies more important than others. Chong (2011) compared the competency of private managers and public sector managers. From the research, it showed managerial competencies broadly similar though the cultural environment was different. Testa and Sipe (2012) developed service-leadership competencies for use in the hospitality and tourism context to address the issue that frontier researchers have less focus on leadership behaviors. Then, it yielded a competency model that contained 100 behaviors. Koengsfeld et al. (2012) developed a competency model for private club managers, it got a model that consisted 10 dimensions which can be used for the development of certification requirements and university curricular offerings.

3 Data Collection

This paper's samples come from the CNKI periodical database. We searched 126 literatures that are about the governmental staff's competency. There are some literatures about enterprise administrators and some repeatability, so we can get 102 literatures of the governmental staff's competency research. Then sorted these literatures according to the cited frequency that is more or equal to ten times. Some authors have several literatures, so we add number after the same author to distinguish his or her different research.

For the study we need to construct a matrix that authors are cited at the same time. There are two main methods now, one is to download the literatures in the corresponding database first, and then to code these literatures to find the cited frequency; another way to construct the cited matrix is to use the retrieval function of the cited at the corresponding database to get the cited frequency. For this paper, we use the first method to get the cited matrix, the cited matrix as Table 1.

Table 1 The cited matrix

Number	v1	v2	v3	v4	v5	v6	v7	v8	v9	v10	v11	v12	v13	v14	v15	v16	v17
v1	13	10	11	6	12	11	6	4	8	4	6	8	5	0	3	1	1
v2	10	13	8	12	9	7	8	8	9	2	1	2	4	0	2	2	4
v3	11	8	12	3	2	3	5	2	4	3	0	4	1	1	1	0	1
v4	6	12	3	13	7	4	10	5	9	2	2	2	2	0	1	2	3
v5	12	9	2	7	13	7	4	3	4	3	3	1	3	0	1	3	2
v6	11	7	3	4	7	12	3	2	6	5	2	2	1	0	1	0	1
v7	6	8	5	10	4	3	11	4	6	1	1	3	1	0	1	1	3
v8	4	8	2	5	3	2	4	9	3	2	3	3	2	0	2	3	2
v9	8	9	4	9	4	6	6	3	10	3	1	1	1	0	2	0	1
v10	4	2	3	2	3	5	1	2	3	6	1	4	1	0	1	0	2
v11	6	1	0	2	3	2	1	3	1	1	7	3	4	0	1	4	0
v12	8	2	4	2	1	2	3	3	1	4	3	9	2	1	0	0	3
v13	5	4	1	2	3	1	1	2	1	1	4	2	6	2	1	5	0
v14	0	0	1	0	0	0	0	0	0	0	0	1	2	4	1	3	1
v15	3	2	1	1	1	1	1	2	2	1	1	0	1	1	4	2	1
v16	1	2	0	2	3	0	1	3	0	0	4	0	5	3	2	6	1
v17	1	4	1	3	2	1	3	2	1	2	0	3	0	1	1	1	5

4 Data Analysis

4.1 Social Network Analysis

Social network analysis measures aspects of social and community relationships to understand relationships between people. Social network analysis illustrates the structure of social interaction by mapping actors, typically individuals, and their social relationships. Social network analysis provides a visual representation of data that can be interpreted without in-depth knowledge of the underlying methodology (McLiden 2012). Studied the data use the method of social network analysis can display the relationship of the authors directly. The relationship of these authors is as Fig. 1.

4.2 Cluster Analysis

Cluster analysis is the core technology in the field of data mining technology. It is based on the basic principle of gathering data inner maximum similarity and dividing the data into several groups to find out the spatial distribution (Mei Yingnie and Xin Juanzhou 2012). With the cited matrix, we can get the cluster tree, as Fig. 2.

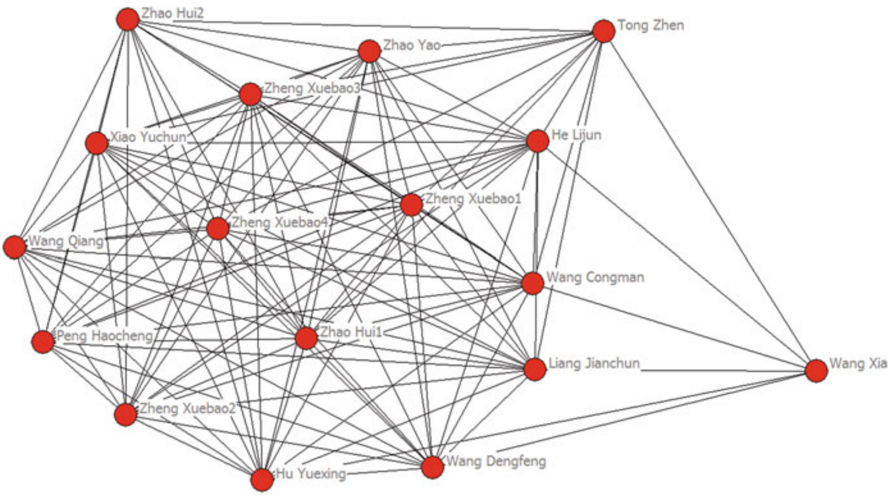

Fig. 1 The network of the high frequency cited authors

5 Result

As the cluster tree show in the Fig. 2, it can be divided three areas of the research of the governmental staff's competency: the introduction of competency concept into the assessment of the governmental staff's ability, the basic unit governmental staff's competency research, and the governmental leader's competency research, they are also the frontier areas of the research.

The first area is the introduction of competency concept into the assessment of the governmental staff's ability. This area focuses on the steps, construction method, and the significance of human resource management for the government of the construction of the governmental staff's competency model. It belongs to the basic research of the governmental staff's competency research, it likes to discuss the questions how to build, what to construct and why to build, so as to lay a foundation for the study of the governmental staff's competency.

The second area is the basic unit governmental staff's competency research this area focuses on the common staff of the government.

The third area is the governmental leader's competency research. The level of the leader's ability not only affects himself, but also has impact on the public' confidence of the government. Some authors investigate competency features of the governmental leader by questionnaire, and some authors explore the different factors' impaction on the competency, such as post height, work experience, education degree and so on.

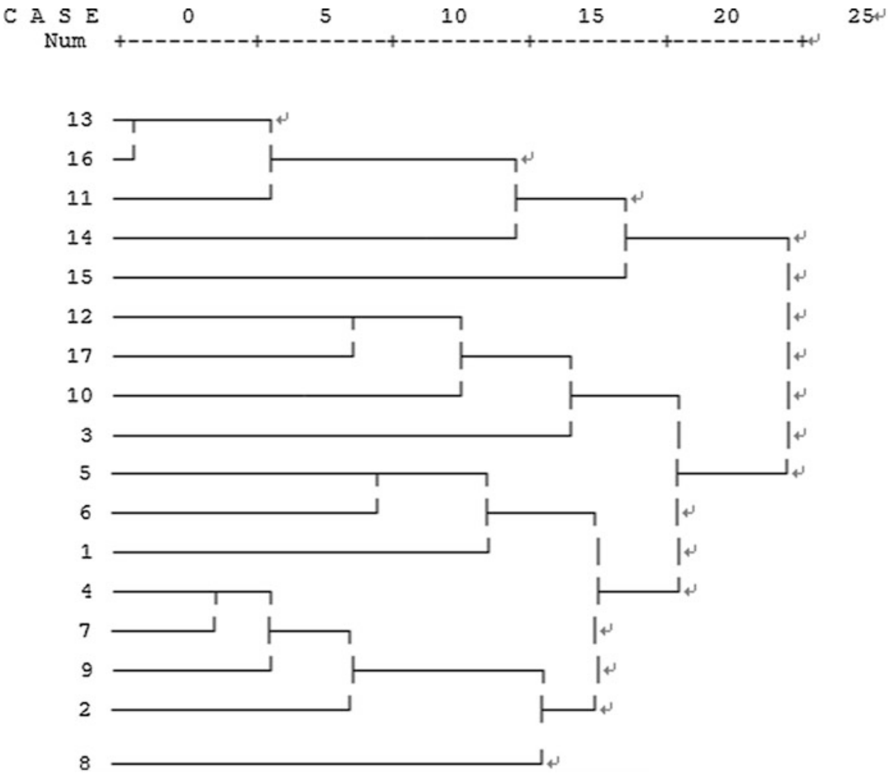

Fig. 2 The cluster tree

6 Conclusion

By utilizing the method of cluster analysis, we get three hot spots of the governmental staff's competency research of the last 10 years. From the number of the literature, it is less, only 102 literatures can be useful, and the cited frequency is low too. It shows that the Chinese governmental staff's competency research is still in the early stage, and it is not yet mature. The research of the governmental leader's competency will lead to the development direction in the field of the governmental staff's competency research. The current governmental staff's competency research focused on the construction of the general competency model, for different positions, the work may be different, and the competency may be different too. Therefore, the future research of the governmental staff's competency should explore the difference of the position and study deep. Theoretical research is to practice in the work, governmental staff's competency research is in order to provide a solution for the governmental human resources management ultimately, and improve the efficiency of the human resource management, thus the governmental staff's competency research should return to the way of human resources practice, constantly improve the research methods, research process.

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Managing Intangible Assets of Sports Celebrities in China

Xin-ping Zhang, Rui-hua Shang, and Xiao-yu Zhang

Abstract In China, generous governmental funding of elite sport development has contributed to the Chinese sport industry rapid growth. With increasing numbers of sports activities and mass media broadcasting, famous professional athletes are more popular than ever. Despite the dramatic developments in sports industry and the sports celebrities, the topic of management of intangible assets of sports celebrities, especially commercial development of the intangible assets in China has received insufficient academic research attention. The research in this paper aims to analyze the characteristics and meaning of commercial development of intangible assets, based on the definition of the star athletes, combining the contents of intangible assets, and finally some reasonable development strategy provided for the administrative sectors, sports agent and sports celebrities.

Keywords China • Intangible assets • Managing • Sports celebrities

1 Introduction

In China, generous governmental funding of elite sport development has contributed to the Chinese sport industry rapid growth (Yang et al. 2008). According to Morgan's investigation, sports events had driven the value of sports-related industries in China to \$1.4 billion (0.3 % of China's GDP) by 2004 and were expected to double by the end of 2009, following the Beijing Olympic year (JPMorgan Chase & Co. 2005). The 2008 Beijing Olympics served as the centerpiece of these efforts, with the Chinese Olympic team topping all nations by winning 51 gold medals (Roberts 2008). Additionally, several elite international sporting events

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(e.g., Masters Tennis Cup, pre-season National Basketball Association games, Formula One Grand Prix Racing, World Golf Championship—HSBC) have taken place in China since 2004 (Liu et al. 2007). Compared with the value of sports-related industries in the USA (3 % of GDP), the business potential in China seems great. More and more top-tier sporting events, such as the Olympic Games, NBA pre-season games, Formula One racing, PGA golf tournaments, and Masters Tennis Cup matches, are being held in China. Given increasing numbers of sports activities and mass media broadcasting, famous professional athletes are more popular than ever (Matthew Tingchi Liu 2011).

These top tier events typically involve high profile celebrity athletes, many of which are presently serving as product endorsers for global products. Houston Rockets basketball star Yao Ming is arguably the most notable Chinese celebrity athlete endorser (CAE). Yao's endorsement deals with Reebok, Apple, VISA, TAG Heuer, Gatorade and McDonald's reportedly total more than $20 million.

Because an athlete's Olympic performance left a lasting impression and he is something to look at in addition, he will surely be a firm future favorite with various sponsors, both at home as well as abroad. Liu Xiang is a prime example of the above-stated. After his inspiring success in Athens 2004, the 21-year-old hurdler became a national icon overnight. His new status caused his earnings to go from 1.6 million yuan in 2004 up to 163.2 million yuan in 2008, according to Forbes' data.

After the long term training and going to the competition on the global games, sports celebrities obtain outstanding sports score and have a higher visibility and influence. At this point, right of name, portrait right and other intangible resources of these star athletes, although do not have the object form, it has great value and has become a kind of intangible assets which can bring economic benefits. So the commercial development of intangible assets has become a trend of commercial activities.

In the western countries, sports celebrities are seen as a human brand and to be taken a serious commercial development and gained a lot of profit through different commercial promotion. Among those, endorsement is the most important and effective way. There is a wealth of potential intangible assets resources of star athletes in China, but various reasons resulting in the commercial extent is still relatively low, it is difficult to obtain a qualitative improve in a short term; Staff with a reasonable, well-organized team of professional brokers are essential for the successful development of intangible assets; commercial development of intangible assets of star athletes is a complex systematic project, which requires efforts in many aspects. We can also selectively learn from successful measures of other countries, such as establish the athlete unions, pay more attention to the importance of commercial contract and sign the commercial contract with the star athletes and so on (Li 2009).

Despite the dramatic developments in sports industry and the sports celebrities, the topic of management of intangible assets of sports celebrities, especially commercial development of the intangible assets in China has received insufficient academic research attention. The research in this paper aims to analyze the characteristics and meaning of commercial development of intangible assets, based on the definition of the star athletes, combining the contents of intangible assets, and finally some reasonable development strategy provided for the administrative sectors, sports agent and sports celebrities.

2 Research Methodologies

In this paper, we mainly study on commercial development of intangible assets of Chinese star athletes. The methodologies of literature, case studies, expert interviews, logical analysis are applied.

2.1 Literature Review

To meet the needs of the study, a lot of literature about economics, intangible assets, and the monographs of marketing, sports industry, sports agents, and sports research methods were collected. Through online searching, we access to the China Academic Journal Database since 1994, China's outstanding Master Doctoral Dissertation full text database, China People's University data center and the number of academic papers and other related articles. Accessing to the Library of the Capital Institute of Physical Education, Beijing Sports University Library, the National Library, we find the literatures of star athletes, intangible assets. Through carefully reading the results of previous studies we got the basic understanding of relevant background knowledge and formatted a theoretical foundation.

2.2 Case Study

This paper chose the main business activities of domestic and international star athletes as case to study. Comparing the successful and unsuccessful commercial development of different players, the problems and the status quo of China's star athletes were analyzed.

2.3 Expert Interviews

In this study, in order to get the more information and some advice about the study, the researchers visited, e-mailed and called some professors who are experts in this field. They are: professor Zhang lin, Shanghai Institute of Physical Education, professor Luo Bingquan, Capital Institute of Physic al Education, professor Lu Yuanzhen, South Normal University, and some faculties working in the Ministry of Commerce.

2.4 Logical Analysis

The researchers followed the logical rule to analyze the information from the literature and interview, and use inductive and deductive method to draw the conclusions of this study.

3 Definitions and Categorization of Intangible Assets of Sports Celebrities

3.1 Definitions of Intangible Assets of Sports Celebrities

Intangible assets have a broader meaning in the intellectual capital (IC) literature than in prevailing accounting standards. For clarity of meaning in the current study, the following definitions and examples were provided. Intangible assets are: “all the assets/resources, elements and capacities that are attributed to an organization and contribute to the delivery of the organizational strategy, which are not currently recognized and disclosed in the balance sheet”. Intangible assets are collectively referred to as intellectual capital. Examples of such intangible assets include among others skills, know-how, brands, corporate reputation, and organizational capabilities, relationships with customers and suppliers, and employee innovativeness (Steenkamp and Kashyap 2010). As for the definition of intangible assets of sports celebrities, some scholars pointed that athletes’ intangible asset refers to the assets that carried by the athletes and their portrait, name, etc. owned and controlled by athletes and the related organization, there is no physical form, but the long-term economic benefits (Yang-Qian 2006).

3.2 Categorization of Intangible Assets of Sports Celebrities

Due to the presence of its intangible characteristics Athlete’s intangible assets showed the complexity of its content. According to the characteristics of intangible assets and related laws, regulations, documents, and other provisions in conjunction with their own understanding of athletes intangible assets, some scholars believe that athletes honor, reputation, affinity, and the influence consisted intangible assets, but not contains the names of the or portrait of athletes (Deng Chun-Lin 2006).

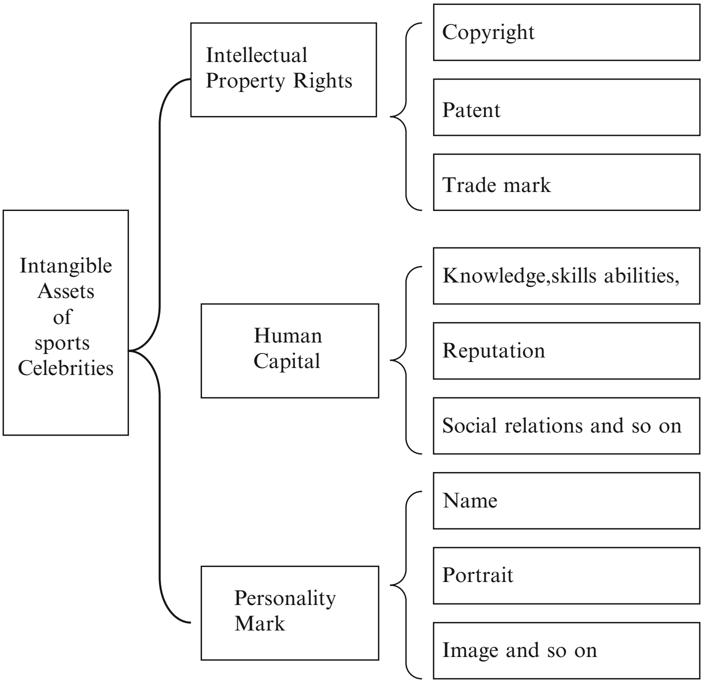

Fig. 1 The category of intangible assets of sports celebrities

Some scholars from the legal point of view pointed that athletes intangible assets consists of three parts, namely, intellectual property, human capital, and commercial exploitation of personality identity (Zhu Wen-ying 2007). Its content is showed in the Fig. 1.

4 Developing Intangible Assets of Sports Celebrities with Brand Strategy

4.1 Building the Human Brands of Sports Celebrities

Human brands may be viewed as one of several operationalizations of the broader concept of a brand. In marketing, the term "brand" is typically applied to firms, products, and services, and in general, marketers accept that brands may be described in terms of perceived quality, image, and so forth (Thomson 2006). Celebrities can also be considered brands because they can be professionally managed and because they have additional associations and features of a brand. "Your client, whether they are an athlete or an actor or an actress, has intangible assets: a name, a reputation, credibility and an image. All of those attributes may be combined into something that could be made into a brand."—Brian Dubin (quoted in Towle 2003).

Branding is another issue of great interest to athletes. Branding has been defined as "the act of associating a face, feeling, image or personality with a business or a product in an effort to create a connection [with] consumers (Wood Rattray 2012)". Of course, many companies have found that using the face of a well known athlete is tremendously good for business, though the experts will tell you choosing a great athlete is not enough. The company should decide on an athlete who can embody and project the best aspects of company's values and personality, even to the point of becoming the face of the business. Such an arrangement will involve a license agreement entitling the company to use the athlete's name, signature, voice, image, likeness, or other identifiable attributes. Licensing agreements can be very lucrative for the parties concerned and for this reason may last even beyond the best years of an athlete's career into retirement. Michael Jordan exemplifies an athlete whose image has remained highly marketable long after his successful basketball career.

4.2 Protecting the Intellectual Property Rights (IPRs) of Sports Celebrities

The Intellectual Property Rights (IPRs) of athletes is a relatively new and developing area of law which is of immense importance to professional athletes in diverse sports such as track & field, football, cricket, basketball, hockey, swimming, tennis, cycling, and even the more esoteric car-racing, yachting, gymnastics and ice-skating. All professional athletes have to deal with issues such as image rights and branding, and yet surprisingly many do not take the necessary steps of having their name or valuable aspects of their image protected.

IPRs such as copyrights, trade marks, patents and trade secrets are intangible assets which have become a significant revenue source not only for athletes but also for clubs, leagues and organizers' of sporting events. Logos, colors and emblems hold significant commercial value and are essential components of branding and merchandising schemes. A great deal of effort is made during international sporting events to project the brands of sponsors who expend enormous sums to purchase the visibility of their brands to an international audience during the viewing of the events. As much effort is taken to exclude competitors who may try to take advantage through increasingly ingenious methods of ambush marketing.

"Every time an endorsement deal is signed, a stadium is named, a team's logo is created, or an athlete performs a sports celebration move on the field, numerous intellectual property issues arise. Intellectual property, though often overlooked, by laymen because of its intangibility, is often among the most valuable of assets that can be owned, acquired, and licensed." With the growing commercialization of sport, athletes need to understand the basic concepts of IPRs so they can protect and exploit their assets. By the same token, the viewing public needs to appreciate the value and importance of these intangible assets.

One of the issues of great importance to athletes is image rights which broadly speaking are the legal rights associated with the image of a celebrity in marketing and promotional activities. Image rights can be owned by the athlete or a commercial corporate vehicle controlled by the athlete, or by their associated team, league or club, or the federation in charge of the sport. "Image" comprises a multiplicity of features such as the athlete's name, nickname, initials, signature, endorsement, reputation, voice, video or film portrayal, computer generated or animated portrayal, photographs, biographical information, graphical representations, images or facsimile image and all other identifiable characteristics of the person.

4.3 Commercial Exploits of Intangible Assets of Sports Celebrities

Commercial development of athletes' intangible assets has different ways for different contents. From the view point of athletes, the commercial development of intangible assets refers to that athletes use their own popularity or personal achievements to assist enterprises to strengthen its commercial sales or product brand image through advertising through a win-win business activity.

4.3.1 Selling Trade Marks or Patents

Registering a trade mark or series of marks protecting aspects of an athlete's image such as a name, signature or even a profile, gives the owner an exclusive right to use the mark in trade for specified goods and services. Registration also gives the right to license the use of the marks which can generate extremely lucrative license fees and royalties. In addition, trade mark registration gives the owner the right to prevent unlicensed persons from using the mark. Even so, as useful as trade marks can be, they may not allow for the full measure of protection an athlete may need to control his or her image. Registering a signature, nickname or even a specific likeness as a trade mark only protects against use of the specific depictions covered by the mark in relation to the specified goods and/or services. An athlete has to look to other species of IPRs in order to broaden the protection required. For example, one must rely on copyright to act against the unauthorized use of photographs and other portrayals on video and film. The point is that an athlete cannot rely on any one IPR, but must look to a range of IPRs in order to achieve the level of protection necessary.

An intriguing question that often arises in professional sports concerns the issue of celebration dances or moves, such as Usain Bolt's famous "To the World" salute. While trade marks can provide some level of protection, persons have wondered how these unique moves can be safeguarded against imitation and use by others even on the field. Abromson notes: “These moves are valuable. Any professional athlete . . . has a limited career span during which he can capitalize financially through his performance on the field, the court, or the rink. These moves, most often performed after an athlete completes a big play to help his team, draw attention to an athlete’s athletic prowess on the field, increasing his marketability and thus his ability to earn money from the endorsements and apparel contracts. To protect the players’ rights in these moves, which carry such a potentially great value, the player should have his move copyrighted. But are these moves eligible for copyright protection? What characteristics must a move have to be copyrightable? Should these moves be protected? What happens when a player performs another players’ copyrighted move?”

4.3.2 Endorsement

Celebrity endorsements are one of the most popular advertising strategies that used in today’ global marketplace (White 2004). In the United States, about a quarter of all ads feature a celebrity endorser (Shimp 2000). In an effort to maximize persuasive advantage, U.S. firms invest heavily in the use of celebrity endorsements, sometimes running into the millions of dollars per endorsement deal (Simmers et al. 2009). In Japan, nearly 70 % of television commercials feature a celebrity (Kilburn 1998). Benefits of using celebrity endorsements include an enhancement of ad recall, product desirability, and product glamour (Spielman 1981). Other research suggests celebrity endorsements are an effective strategy for gaining and holding attention (Atkin and Block 1983), positively impacting brand attitudes and enhancing likelihood of purchase (Friedman and Friedman 1979), fostering brand loyalty, and positively impacting word-of-mouth (Bush et al. 2004). Among the list of top 10 highest paid athletes, most of them gained lot from endorsement (showed in Table 1).

Compared with those highest paid athlete in the word, the top 10 earning athletes (Table 2) in China earned much less. Main reason is that the commercial exploit of sports celebrities are lagged behind.

4.3.3 Development of Copyright

Many famous players publish their autobiography and gained a lot from selling books. Chinese athlete Liu Xiang, winner of gold medal in the men’s 110-m hurdles at the Athens Olympics, published his autobiography in 2004, “I Am Liu Xiang,” another Shanghai native, basketball giant Yao Ming, who also recently published his autobiography, “A Life in Two Worlds.” Manager Dai, the editor in charge of the book.

Table 1 Top 10 highest-paid athletes in the world (2012)

Rank	Name	Sport	Nationality	Total Earning	Salary/Winnings	Endorsement
1	Floyd Mayweather, Jr.	Boxing	United States	$85 million	$85 million	$0
2	Manny Pacquiao	Boxing	Philippines	$62 million	$56 million	$6 million
3	Tiger Woods	Golf	United States	$59.4 million	$4.4 million	$55 million
4	Lebron James	Basketball	United States	$53 million	$13 million	$40 million
5	Roger Federer	Tennis	Switzerland	$52.7 million	$7.7 million	$45 million
6	Kobe Bryant	Basketball	United States	$52.3 million	$20.3 million	$32 million
7	Phil Mickelson	Golf	United States	$47.8 million	$4.8 million	$43 million
8	David Beckham	Football	England	$46 million	$9 million	$37 million
9	Cristiano Ronaldo	Football	Portugal	$42.5 million	$20.5 million	$22 million
10	Floyd Mayweather, Jr.	Boxing	United States	$85 million	$85 million	$0

2012 as ranked by Forbes magazine on their earnings in United States dollars. http://www.forbes.com/athletes/list/

Table 2 Top 10 highest-paid athletes in China (2012)

Rank	Name	Sport	Total earning
1	Li Na	Tennis	$18.40 million
2	Liu Xiang	Track and field	$6.22 million
3	Sun Yang	Swimming	$4.91 million
4	Lin Dan	Badminton	$4.26 million
5	Liang Wenchong	Golf	$2.54 million
6	Feng Shanshan	Golf	$2.45 million
7	Zhang Jike	Table Tennis	$2.13 million
8	Yi Jianlian	Basketball	$2.13 million
9	Yi Siling	Shooting	$1.80 million
10	Zheng zhi	Football	$1.80 million

5 Conclusions

With the development of socialist market economy, the commercial value of star athletes are increasingly being recognized, the commercial development of intangible assets has become a trend of commercial activities. There is a wealth of potential intangible assets resources of star athletes in China, but various reasons resulting in the commercial extent is still relatively low, it is difficult to obtain a qualitative improve in a short term; Staff with a reasonable, well-organized team of professional brokers are essential for the successful development of intangible assets; commercial development of intangible assets of star athletes is a complex systematic project, which requires efforts in many aspects. We can also selectively learn from successful measures of other countries, such as establish the athlete unions, pay more attention to the importance of commercial contract and sign the commercial contract with the star athletes and so on.

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The Current College Students' Employment Situation Analysis and Countermeasures to Explore

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Abstract As China's "development through science and education" strategy implementation, China's higher school education development, the number of college students has increased dramatically, social employment capacity reduction, lead to college students' employment difficult problem has become one of the social hot spots. This article from the contemporary university students' employment problem of present situation, analysis of the current problems existing in the employment of university students and the reason, thus in the country, school education, social and personal four puts forward solving related countermeasures and measures.

Keywords College students • Countermeasures • Employment

1 The Current University Student's Employment Situation Analysis

June 2011 to July, China's national college students' information consultation and employment guidance center in the nationwide in 2011 the Chinese college students employment status (preferred) survey work, this is the 2001, 2004, 2007, 2009 and 2010 years later the sixth survey.

The network investigation, the object for 2011 sessions of graduates. Through the province, universities, students level 3 for stratified sampling, make sure all the provinces of the sample survey of school. The school graduates notice, within the prescribed time independent Internet fill questionnaire, complete the investigation.

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This investigation for a total of 45,348 valid questionnaire. College covers a wide range, including “985”, “211” university college, the common universities and colleges of undergraduate course, independent institute, such as higher vocational colleges 443 institutions of higher learning; Sample professional distribution covers all the 12 big content area kind, Survey area including over 30 provinces, autonomous regions, municipalities directly under the central government of university; Sample including already employment and not the employment of graduates (Liu Hui and Zhang Cai 2006).

In the effective samples, according to gender division, accounted for 51.0 % of men, women accounted for 49.0 %, men and women ratio is 1.04:1. Among them, the han nationality accounts for 90.7 %, ethnic minorities accounted for 9.3 %. According to the record of formal schooling division, college degree 38.9 %; Bachelor degree 56.0 %; Master degree or above accounted for 5.2 %. From students to view, student graduates central proportion is the largest, is 48.5 %, the eastern students graduates accounted for 32.9 %, the western students graduates accounted for 18.6 %. From the family to see, capital city graduates 15.5 %, city specifically designated in the state plan graduates 4.4 %, locally administrated level city graduates 20.9 %, county-level cities of city or county graduates accounted for 19.6 %, 10.6 % of villages and towns graduates, rural graduates accounted for 28.9 %. From colleges and universities constitute a view, higher vocational colleges graduates the largest proportion, for 34.9 %; The second is ordinary undergraduate course graduates, 30.0 %; “211 project” and “985 project” university graduates accounted for 18.7 %, independent colleges and universities graduates accounted for 16.1 %, other types of graduates accounted for 0.3 %. From professional constitute a view, engineering graduates the largest proportion, for 34.3 %; The second is economics, science, literature and management professional graduates, accounted for 13.7, 11.8, 11.1 and 10.9 %; The rest of the proportion of graduates is relatively low.

According to the 2011 China college students employment condition investigation data of deep analysis, we can draw the following conclusion:

1. 2011 years college graduates employment rate 69.1 %, graduates legal consciousness unceasingly strengthens, the employment form more standardized and professional further ease the contradiction between supply and demand. By the end of this network survey, investigation of the employment of college graduates was 69.1 %, lower than in 2010 (76.1 %). But because the investigation cut-off time significant difference, the 2011 college graduates employment there still exists certain separation space. From the graduate signing state see, has signed a contract graduates (including the verbal agreement with unit of choose and employ persons employment) accounts for 47.2 % of the overall survey, 52.8 % of the graduates in preparation enters a higher school, wait for contract signing, unemployment and did not sign state (Jia Li 2007).

Specific perspective, vocational college graduates signing rate slightly tall, is 50.1 %, the second is “211” and “985” project college graduates, signing ratio is 49.3 %, independent colleges and normal universities and colleges of undergraduate course graduates signing rate were 44.6 and 44.1 % respectively, the undergraduate course colleges and universities graduate employment slightly prominent contradiction.

From professional perspective, signing rate is the highest engineering graduates, 61.1 %, secondly respectively is 49.8 % of management, economics 45.7 %, 40.7 % of science, signing ratio is lower in the education, history, military science, respectively is 23.7, 23.9 and 25.3 %. The employment of college graduates professing rate (90.6 %) than in 2010 (86.8 %) increased, professional further ease the contradiction between supply and demand. Among them, the medical and engineering graduates professing the highest rate, and law and history professional graduates professing rate minimum; Men, higher vocational colleges, engineering, and other professional, graduate student degree graduates signing rate relatively high (Zou Yun Long and Cao Yang 2009).

Already signed in graduates, but also enterprise graduates proportion is the highest, about 78.9 %, other types of unit are distribution.

Unit of choose and employ persons in has been signed by the graduates to obtain employment agreement signed form graduates of the largest proportion, at 72.7 %, was 22.6 % higher than in 2010, and to verbal agreement signed in the form of the proportion of smaller, at 2.6 %, indicating that our country socialist employment market gradually perfect, the employment of college graduates form more standardization and rationalization, the legal system (Li Ying Jun 2008).

2. The employment of college graduates are satisfaction, employment expectations and the reality contradiction between employment has eased.

In 2011, the employment of college graduates satisfaction scoring 63.3 points (full marks meter for 100 points), satisfaction are more than in 2010 nearly 10 points (2010 to 53.7 points). The employment of college graduates satisfaction and graduates gender, school level, professional, family location, the starting salary and signing unit properties characteristic variable has significant correlation. Among them, the men, higher vocational colleges, college education, philosophy professional, urban students, the starting salary is higher, signing state organs and graduate employment satisfaction is relative taller.

Meanwhile, the influence of the international financial crisis further revealed, and it is predicted that in the future a quite long period of college students' employment pressure unabated. How to help college students out of the plight of difficult employment will become the government and social long and difficult the task of princes (Jie Wu 2009).

College students' difficult employment is a real problem, but also a social problem. Generally speaking, university graduates with high level of human capital are the Labour market advantage group. But with the development of globalization and knowledge economy impact, youth first and continuous employment the ability sill increased year by year, college students must have can meet the requirements of the new economy core employment ability to be successful development, but the existing education and training system, lack of necessary job market demand-oriented, lack of entrepreneurial behavior of thorough research, higher education training out of college students in the knowledge and skills on the structure and the talent market demand exist apart, college students employment structural contradiction.

2 The Paper Analyzes the Causes of College Students' Employment Situation

2.1 The Expansion of Enrollment in Colleges

College expansion of college students' employment has much influence? We can see from the Table 1, since 2000, the number of graduates is growing every year, in 2009 the number of graduates in 2000 more than five times. With the increase of the number of graduates, looking for a job is becoming more and more fierce competition, the employment it is more and more difficult also. College expansion of university students' employment increases the difficulty, but in the country's long-term interests look, college expansion is also a necessity a choice. College expansion of university students' employment has been an effect, but the reason is various, also is not the main influence.

2.2 University Student's Employment Flow

The flow of college students employment are mainly from five aspects, we can see from these to college students' employment difficult concrete embodiment: 70 % graduates employment way is mainly to the various enterprises and urban and rural community service post employment or start their own businesses, flexible employment. But 70 % does not mean to urban and rural community service post employment, but includes to all kinds of enterprises (private enterprise multinational companies, the world's top 500 enterprise, etc.) and flexible business scale. The proportion of independent business of 0.3 %, are willing to urban and rural grassroots service post, the number has not much. Visible, although many college students, college students do not wish to go to work at the grass-roots level, industry not is also causes the problem of university students' employment outstanding one reason (Wei Gao 2009).

Table 1 The number of college graduates in times questionnaires

Years	2000	2002	2003	2004	2005	2006	2007	2008	2009
The number of graduates (10,000)	115	145	212	280	340	413	495	559	611

2.3 The Spatial Distribution of College Students' Employment

College students' employments most concentrated to the developed areas and high salary employment department and are willing to less developed areas of work less. In Guangzhou, Shanghai, Beijing fresh graduate student first choice, few people are willing to employment in the western region. A study of more than 3,000 graduates survey shows that, the preferred to Beijing to work as high as 74.8 %, the preferred to only 2 % of the Midwest. These graduates income desire value is 2,000–4,000 yuan per month, lower than 2,000 yuan a month resolutely do not do it. This caused the heavy east, west light; Heavy top, light grassroots not reasonable distribution. If college students employment space reasonable distribution of words, the employment problem would not be so severe or does not exist the problem of employment. The problem of employment to the west is our solving the employment difficult to the crux of the problem, but also conducive to the realization of social development level of equilibrium, the state's common prosperity, university students' employment problem in some degree is relative excess, and this is the concept of college students employment choice caused by unreasonable space layout is closely related.

2.4 The Disadvantages of Education Mechanism

Our education system itself exists a lot of problems. Some professional overheat, the emergence of a cluster phenomenon, some professional is deserted, a lack of talent. Many college students in the university wasted because precious youth, no to improve their ability. The university education mechanism have relations, a lot of education activities just go work, since form, the surface is completed education task, no further inspire students' potential. Some students reaction, their learning level and the innovation ability than senior high school time dropped a lot, and quite a few.

3 In View of the Current College Students Severe Employment Situation Countermeasures

View of the present university student's employment problems facing, to make the problem to ease, take various effective measures. Need to country, enterprise, college students themselves, education institutions all aspects efforts.

3.1 National Aspects

1. Stable employment environment.
   Set rules to protect the vital interests of college students' employment. For example, the minimum wage regulations, and according to the financial turmoil, but also to create a stable employment environment. And to balance small and medium-sized cities in the pearl river delta and the talent competition for graduates to the government actively, such as rural grass-roots unit work create conditions, such as: open up perennial and standardization of the channel, and strengthen the propaganda guidance work; For the basic unit work graduates provide some preferential policies; We need to care about the development of these graduates, so that they really feel great at the grassroots level as.
2. Create a fair employment opportunities.
   Ensure that just to enter the society of college students and the society has experienced workers can be equal in the labor market. At the same time, establishing and perfecting relevant laws, regulations, regulating the job market for college graduates. Establish and perfect laws and regulations, such as college students employment law, talent law, graduate employment market management regulations, etc., so as to gradually make the graduates' employment osa standardized and institutionalized, and ensure that graduates and unit of choose and employ persons the rights in two-way choice.
3. Speed up the adjustment of personnel training structure.
   To further increase the social need professional recruit students number, control long term professional development scale, the teaching quality is not high, professional setting is reasonable and lead to low rate of university graduates of colleges and universities and professional, to reduce the number of recruitment of students
4 College graduates to broaden employment channels at the grass-roots level.
   Encourage college graduates big base, to small and medium-sized companies, hard to place to work.
5. Solve the private company hiring of college graduates related problems.
   The private enterprise of the employment of college graduates, the public security organ are actively relaxed establish a collective registered permanent residence of the examination and approval conditions, encourages and supports the college graduates start their own businesses, and the industry and commerce and tax departments shall simplify examination and approval procedures, and actively to support.
6. To strengthen the college graduates employment guidance.
   To strengthen college students to correct world outlook, outlook on life, values and the corrected education, that they are set up independent careers, hard working, the concept of lifelong learning, set up according to the needs of society obtain employment, to a primary building a solid career thoughts, the initiative to the motherland needs place a career. Relevant government departments

should earnestly, the employment of college graduates, in order to improve employment rate as the center, the improvement of the employment guidance, and comprehensively improve the service level (Yingying Pu 2008).

3.2 Education Mechanism Aspects

Schools should constantly strengthen the soft and hardware facilities construction and the construction of the teaching staff, deepening of the reform of teaching content, broaden the students' knowledge, increase the applicability and operability and technical course, practical training with various comprehensive skills can adapt to social needs comprehensive talent. The development of the society without innovation, college students to work in get to realize their own value also cannot leave the innovation, the school only pay attention to cultivate the students' innovation ability, college students have the ability to start their own businesses, and can work in a good performance, create employment opportunities

3.3 Social Aspects

Fair treatment of college students, to reduce the threshold of the college students' employment. Create employment environment without discrimination. Make the staff to enterprise have a sense of belonging, better for the enterprise to pay (Zhou Xia et al. 2003). Thus to bring considerable economic benefits. It is not only the company to its staff manufacturing opportunities, but also enterprise seeks development essential investment. In addition, the enterprise should keep pace with The Times training employees. Because college students just into the enterprise, for business are the lack of professional ability, plus itself just step into society, lack of experience, so enterprise to train them. In the present era, is a moment all change s. Training this noun has become a necessary, is the enterprise full staff ability, the importance of the equipment (Bo Wei 2002). College students, is a more training opportunities to live a group, they just step into society, a lot of things too late to adapt, a lot of things need to learn, the enterprise if can provide more training opportunities to them, let them have more learning space.

3.4 College Students' Aspects of Their Own

1. To improve their comprehensive quality.
   College students to the fierce competition in seeking employment succeed, realize their own values, school learning can only say that is the project, to improve

the comprehensive quality fluctuation kongfu, make their own innovation spirit and practice ability, and drawing on the books outside of the nutrition, in order to meet the society for talents needed should have the quality.

2. To enhance the ability of environment.
College students are facing after graduation is no longer the school small society environment, but the complex society, there are all kinds of people and things, full of all kinds of the unknown factors. In order to let oneself can based on society, move in complex human relations, in addition to college students learn professional knowledge outside, also study a variety of life need, is the so-called skill much to self-defense.
3. To have the innovation ability.
Faced with the severe employment pressure, many college students will choose to start their own businesses, and start their own businesses can reduce the pressure of graduates' employment, but do pioneering work independently but have higher requirements, the innovation ability is indispensable. Only when you have a good contacts, gold vein, know vein these three vein, graduates can have business climate favourable geographical position and condition, can the independent venture to secure their position.
4. Training responsibility consciousness.
Graduates to apply for a job in the former must accurately grasp their own position, in the work actively shoulder their responsibilities, to call talent market sense of responsibility and good faith, for his job to lay a good foundation. Work must adhere to in the end, don't easily job-hopping. Want to have responsibility consciousness, the enterprise is responsible, to be responsible for myself.
5. College students must take precautions, ready (Gui Bing 2009).
Preparedness ensures success and unpreparedness spells failure. Career planning is director of college students through the subjective and objective conditions for measurement, analysis, on the basis of the conclusions according to college students' interests, hobbies, ability, specialty, professional orientation, targeted to help individuals to determine their own goals, and to realize the goals clear ideas, ways to make university students grow up in a way as far as possible on the process of less detours. During the period of school to do career planning, in the choice before employment to make sufficient analysis, graduates can choose appropriate own position, and don't want disorderly throw 1, so that the waste of human resources.

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Explored on the Qualification Standard System in the Human Resource Managements of Research Institutions

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Abstract In China's research institutions and universities, the knowledge staffs are the main and implement the lifetime employment system. Based on analyzed and researched Japan's companies and Huawei's qualification standard system, compared some western management methods and means, combined with our characteristics, learned from the mode of Huawei's qualification management for the knowledge staff, draw on the experiences of staff management in Japanese companies which based on the lifetime employment system, explored and established a qualification standard system which is a "people-oriented, people & things-equated" model. In the qualification standard system, emphasized on "things" management, but also "people", the goals of research institution or university bundle with the staff's needs and interests, the problems of professionalization have been studied, based on the basic conditions and the standards of conduct, built the career development paths of business executives and general management personnel.

Keywords Career development paths • Human resource management • Professionalization • Qualification standard system • Research institutions

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1 Introduction

In China, Practiced and changed in human resource management has been for many years, many domestic enterprises and institutions implemented some western management methods and means, such as the salary management for job evaluation, the performance management for key performance indicators (KPI), and corresponding incentive method and so on (Yong-qiang Liu et al. 2009; Jun-fen Li and Chong Pen 2011; Hao-liang Zhang 2007; Jan Selmer and Randy Chiu 2004). On the one hand, in the past long time, these management methods and means have been widely applied, and have been shown to play a great role, but, on the other hand, these methods and means have exposed many deficiencies, because these management tools mainly based on job or events (KPI), they emphasis on the "thing" management, ignore the "people", they resulted in imbalance management, ineffective, especially, in the domestic research institutes and universities, these problems are very remarkable. the management model excessively emphasis on analysis, quantification, logic, system, so it concern with "thing", not people's characteristics, especially, it isn't matched the characteristics of the intellectual talent, such as values, mission, style, and other soft factors, these characteristics are not measured by a quantified rigid targets. In this way, the results of the evaluation are not entirely accurate, the personal development channels are ineffective, the incentives are imbalance, the good experiences are not passed, so the development of collective and individual is restricted (Brown et al. 2007; Yan 2009). On the basis of careful analysis and study in Japan, and Huawei enterprise management methods and means, combined with our characteristics, explored and established a qualification management model of "people-oriented, people & things- equated".

2 Japanese Management Models

On the human management, Japan's companies have taken a successful step. In many Japan's companies, carry out lifetime employment and collective values, concern with people's characteristics, not "things", so the stability, harmony and coordination of the organization are very good (Yan Peng 2012; Mo-fan Wang 2012). P. F. Drucker predicted, in the twenty-first century, once the Japanese make a breakthrough on the lifetime employment system and the mobility of human resources, over the world will learn from Japan. Drucker also pointed out, if you want to exert the creativity of employees, especially knowledge staffs, you will not take them for "employees", but for "volunteers". You must make them to know the entire organization's mission, and make the goals relate to their interests, and make them believe these. Make sure the rules of value creation and value assessment and value allocation is clear and stable (Drucker 2006).

3 Huawei's Qualification Management System

In China, in some companies, the staff, as an engineer, maybe is an engineer in his lifetime, has not been changed, the career development paths are not clear, so the staff more and more disappointed, and bring about serious problems. In the process of professionalization, these problems will exist all long, especially from the industrial economy to the knowledge-based economy, these problems will be remarkable (Yan Deng 2010). For these problems, the traditional management means cannot do. The Huawei's qualification management system, which concern with people's characteristics, not "things", has better solved these problems.

In Huawei's qualification management system, position management is the basis, professional ability is the core. According to the qualification standard, through standardizing procedures, the ability of the staff is objective and impartial certification. In Huawei qualification system, there are two-way promotion channel, combining with job's requirements, the staff who has management capability or management potential successfully grow up to be a manager, but also the staff who concentrated on studying the technical successfully grow up to be a professional (business) experts in a field. Huawei's qualification system provide a broad space for the staff's career development (Chun-bo Wu 2010; Xi-juan Liu and Fang Mei 2011).

In general, it is mainly to answer the following some important issues.

3.1 Take Company's Goal for a Mission

We know, only really do better the management of staff from their intrinsic motivation, the external factors (such as reward, punishment) can play a role. By taking the company's goals bundled with the staff's personal needs and interests, the staff's career development paths which are determined by qualification standard, the qualification standard which take responsibility and ability and contribution for a core, and the corresponding evaluation means and value allocation mechanism make the company's goals have been internalized into the mission and responsibility of the staff.

3.2 Professionalization of the Work Behavior

Similarly, the staffs need to know how to make things better, by summarizing or studying the successful experience, formulate the standardized operation instruction, cultivate the professional behavior of a staff, let the staff continue to keep these behaviors, their habits are formed naturally, as a result, and the professional accomplishment has been developed. Through the continuous optimization for the operation instruction (ways of doing things), the level of company's professionalism and efficiency are continually improved.

As a summary, Huawei's qualifications system, solved the problem for the junior staff on standardized operation and self-development, solved the problem for existing manager on how to further professionalize, solved the problem for how to find and train new manager as soon as possible.

3.3 The Practice of Huawei's Qualification Management

In Huawei's qualification management system, Contains the following key elements and steps.

1. *The class of Huawei's qualification management system*
   In Huawei's qualification management system, include the technical qualifications, marketing qualifications, specialized qualifications and management qualifications, and are divided into 6 classes, the primary business staff for the 1–2 class, the elite business staff for 3–4 class, the experts for 5–6 class. Every class is divided into four grades: the career grade, the general grade, the basic grade, the spare grade. There is a detail description of the qualification standard for every class and grade.
2. *Build career development paths*
   The qualification combined with the job's position, and provided the career development paths for the staff. By qualification management system, formed two career development paths: the management and professional/technical.
3. *Build qualification standards*
   The qualification standards based on the job responsibilities and requirements, and are evaluation guideline. The qualification standards consist of the successful behavior and capacity factors of the staff, who engage in the work for long time and is excellent. The qualification standards include the basic conditions, the core standards, and reference items. Each standard contains various units, elements and basic standard items.
4. *Qualification certification*
   Qualification certification is an activity of identification, in this process, an applicant is proved whether have the appropriate qualification, including planning, evidence, judgment, feedback, recording conclusions etc. By qualification certification, the certification personnel fully cooperate with the applicant, and help the applicant achieve the qualification standard requirements.
5. *The application of the qualification results*
   The qualification results is regarded as an important source for training needs, is a supplement and refine for the qualification requirement in job description, is a standard for the position in the recruitment.

4 Explored on the Qualification Standards

In China's research institutions and universities, although the employment system has been reforming, but the lifetime employment is still the main, it is similar to the lifetime employment system in Japanese companies. In recent years, with the development of society and advanced in technology, people's lifestyles and behavior patterns are also changed, the lifetime employment system in Japan is subjected to challenge, and exposed some problems, such as blocked the talent mobility, lack of energy, contrary to the modern concept of employment and so on (Peng-yu 2007). Despite has these problems, the lifetime employment is adopted in many Japanese companies as before, and it did not weaken the overall external competitiveness and overseas expansion force. Facts have proved that the lifetime employment system still applies to the current economic situation in Japan, the advantages of high loyalty, strong sense of team and collective sense of honor and sense of belonging are still worthy of studying (Fei 2006).

As a high-tech enterprise, the staffs are mainly knowledge employee in Huawei Company, is similar to the research institutions in China. A knowledge employee has the knowledge capital, so they has the characteristics of autonomy, creativity, achievement, mobility and complexity, the management for the knowledge staffs cannot follow the traditional management methods and means, the changes are needed from adjusting, controlling and manipulating to cooperating, encouraging each other and sharing. The qualification system in Huawei company successful achieved the scientific management for knowledge employee, is worthy to learning. Since the systemic difference between enterprise and institutions, we cannot copy the model of enterprises to the institutions, for example, the stock incentive and stock option incentive in Huawei Company are effective, but in research institutions, are not valid; as same as, in research institutions, there are relatively relaxed environment and good stability, but in enterprises, there are not.

Carefully analyzed and studied the Japanese and Huawei's management methods and means, according to our characteristics, explored a qualification management model which is "people-oriented, people & things –equated", established a qualification standards for the business executives and the general management personnel (Chong-jiang Huang et al. 2011).

5 The Qualification Standards for Business Executives

The qualification standard of business executives contains the basic conditions and the standards of conduct for qualification.

5.1 Basic Conditions

1. *Responsibilities*

   - Be responsible for the management of a business department
   - Assist the department competent to allocate resources, ensure to take rationally advantage of resources.
   - Research and analysis the policies, provide an effective basis for manager.

2. *Professional quality*

   - Leadership skills: be able to lead people effectively work together
   - Planning and organizing skills: coordinate and allocate the resources; effectively develop his own or team's work plan; take the effective and timely action.

3. *Job experience and requirements*

   - Education: University degree or above, professional unlimited.
   - Work experience: to fulfill the qualification standards; Engaged in management over 3 years; Familiar with the business knowledge, the legal knowledge, the economic and psychological knowledge, the knowledge of human resource development management.

4. *Job performance*

   - The annual assessment is above qualified, and at least one is excellent in 4 years.
   - Obtain the appropriate post allowance, performance benefits and the other treatment.

5. *Others* (*Including rewards or punishments*, *training records and scores*)

   - In work, the rewards or punishments and training scores are recorded, and impact on qualification. These records are regarded as a basis for promotion.

5.2 Standards of Conduct for Qualification

1. *Management a business in a department*

   - Plan, organize a job and orderly carry out.
   - Use appropriate methods, rationally arrange and grasp the progress of a job.
   - Coordinate and supervise a job, and complete the job with the quality and quantity requirements.

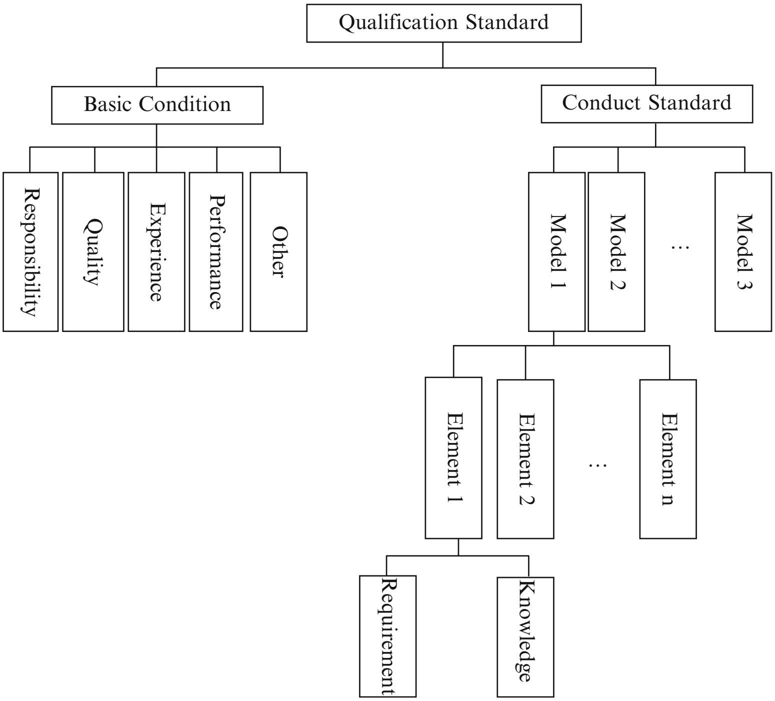

Fig. 1 General management personnel qualification standard structure

2. *Assist in planning and monitor the progress of a job*

- According to the requirements of the department heads, consult with the competent, organize a job and orderly carry out.
- Rationally arrange and grasp the progress of a job, monitor implementation of the objectives.
- Strengthen communication and coordination.
- Complete the job with quality and quantity requirements.

3. *Research*, *prepare and provide information*

- Research, collect and select information to meet the specific needs.
- Prepare and provide information to meet the specific needs.
- Summary the investigation and research process, and report to the competent and related people.

4. *Create and maintain an effective working relationship*

- Create, nurture and maintain effective working relationships with colleagues.
- Create, nurture and maintain effective working relationships with external personnel.

6 General Management Personnel Qualification Standard Structure

General management personnel qualification standard structure is shown in the Fig. 1.

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A Survey and Study on Competence of the Little Village Official—Taking Suqian City of Jiangsu Province as an Example

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Abstract This paper is to check the competence model for the little village official which is put forward by Shen Min (Preparation of the questionnaires concerning competence of the little village official [D], Thesis of Master Degree at Shanxi University, pp 5–15, 2011) by conducting a survey on the competence and performance of the little village official in Suqian of Jiangsu Province, which indicates that such questionnaires are applicable to those little village officials, and to make an analysis on their competence and have a clear understanding of their basic information and competence. Then, together with the related theoretical literature, the author puts forward the suggestions to the further construction of the little village official mechanism in Suqian and to policymakers.

Keywords Competence • Little village official

1 Introduction

The little village official mechanism has grown out of nothing and experienced the stages of exploration, key breakthrough and full implementation since the mid-1990s. It has undergone rapid development and rich experience has been accumulated. In practice, however, it is found that some outstanding results have been gained while some issues require to be solved urgently in such project, among which, one of the prominent issues is competence of the little village official.

The author will conduct a sample survey on the little village official in every village and town of Suqian by utilizing the competence model by the empirical test (source data for constructing such a model and checking its validity do not

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derive from Suqian of Jiangsu Province) (A Research Group from Organization Department and Research Department of CPC Jiangsu Committee 2010). In order to further check its applicability and have a clear and deep understanding of competence of those little village officials in Suqian as well as their differences in competence, Jiangsu province employed such a systematic sample survey for the purpose of offering guidance to the little village official in Suqian and provided references to those in other places.

2 Design and Implementation of Questionnaires

2.1 Selection of Questionnaires

In this paper, the author adopts the Competence Measurement Form of the Little Village Official prepared by Shen Min (2011). This questionnaire is made up of five dimensions with 36 items—active assistance (CA), problem solving (CB), work development (CC), post comprehension (CD) and basic quality (CE) (McClelland 1973).

The reason why the author selects such a questionnaire model from many ones concerning the competence of the little village official is in that such a model is established in a scientific manner and has passed the empirical test, and that sub-items in such model are less than conceptualized and are more based on behavior which applies to the daily work the little village official does.

2.2 Survey Implementation

The questionnaire here is formed by slightly adjusting the Competence Measurement Form of the Little Village Official prepared by Shen Min (2011) after 50 pre-surveys (Cheetham 1998). The questionnaire consists of three parts: competence measurement, performance measurement and personal information (including gender, education, service period, etc.). The survey was made from December 20, 2012 to January 15, 2013 to the little village official in Suqian of Jiangsu Province. The 200 questionnaires were made online through the QQ groups and forums of the little village official in Suqian of Jiangsu Province, and by the means of entrusting my friends to email the questionnaires to the appropriate subject, with 178 questionnaires collected and 157 effective ones, which satisfies the statistic requirements.

3 Results and Analysis

3.1 Sampling

From the perspective of the gender distribution in sampling, the female accounts for about 47.77 % while the male about 50.32 % (three omitted to mark the gender items), and those who are the only child in his/her family take up about 13.38 % and those who are not the only child in his/her family are about 84.71 % (Spencer and Spencer 1993); from the perspective of the educational background, such officials, most of whom are later up to 94.27 % in total, and most of whom have experienced a rural life before graduation up to 79.62 % in total, are only made up of graduates and undergraduates; from the perspective of specialties, those with a degree in management, engineering and literature rank top three among 11, take up 24.20, 22.93 and 14.01 % respectively; from the perspective of service period, those with 1–2-year service account for 41.40 %, and following it closely, those with 2–3-year service take up 27.39 %, and the third is those with below 1-year service occupying 17.20 %, and the last one is those with more than 4-year service making up 5.10 % (Cerase 2002).

In the questionnaires, the competence and performance indicators are measured according to the 5-point Likert scale, thus the maximum and minimum values of each indicator are 5 and 1 respectively. In terms of competence, the little village official involves the appropriate marks based on his/her situation: 1 point means completely un-accordant, 2 points un-accordant, 3 points neutral, 4 points accordant and 5 points strongly accordant; the higher the score is, the better the competence is, except that there are four items scored reversely. In terms of competence, the little village official involves the appropriate marks based on his/her work: 1 point means no, 2 points rarely, 3 points unsure, 4 points sometimes and 5 points often; the higher the score is, the stronger the performance is, except that there are three items scored reversely. The descriptive statistics analysis is listed in the above Table 1 (Li Yueheng and Hu Zhenhua 2009).

3.2 Reliability Test

Reliability analysis has been made concerning the collected data through SPSS16.0, which shows the meaning of Cronbach'α is more than 0.75 and the value of Cronbach'α of all the questionnaires is 0.763, which represents its good internal consistency (Sun 2009).

Table 1 Descriptive statistics analysis

Dimension	Measurement indicators	Mean	Variance	Dimension	Measurement indicators	Mean	Variance
Active assistance (CA)	CA1	4.32	1.82	Relationship performance (RP)	RP1	3.61	1.18
	CA2	4.49	1.15		RP2	3.40	1.28
	CA3	4.33	0.95		RP3	3.58	0.97
	CA4	3.51	1.18		RP4	3.41	1.15
	CA5	4.42	0.90		RP5	3.43	0.99
	CA6	4.42	1.11		RP6	4.43	1.90
	CA7	3.44	1.08		RP7	4.34	1.20
	CA8	3.52	1.16		RP8	4.49	1.17
Problem solving (CB)	CB1	2.52	1.52		RP9	3.54	1.25
	CB2	2.65	1.80		RP10	3.59	1.96
	CB3	3.55	1.27		RP11	3.65	1.07
	CB4	2.55	1.36		RP12	3.56	0.93
	CB5	3.52	1.02		RP13	4.45	1.00
	CB6	2.47	1.07		RP14	4.43	1.16
	CB7	2.76	1.01	Task performance (TP)	TP1	3.60	0.78
	CB8	3.61	2.25		TP2	3.51	0.96
	CB9	2.68	2.08		TP3	3.56	1.99
Work development (CC)	CC1	2.51	0.88		TP4	3.66	1.01
	CC2	3.57	1.02		TP5	3.59	0.98
	CC3	2.72	1.09		TP6	3.72	0.82
	CC4	3.36	1.88		TP7	4.48	1.28
	CC5	3.48	1.24		TP8	4.37	1.06
	CC6	2.45	1.64		TP9	3.55	0.54
	CC7	3.62	1.17		TP10	3.48	0.54
Post comprehension (CD)	CD1	3.63	0.94	Creativity performance (CP)	CP1	3.52	1.90
	CD2	3.57	1.01		CP2	2.62	1.17
	CD3	4.49	0.97		CP3	3.41	1.01
	CD4	3.61	0.93		CP4	3.41	1.17
	CD5	3.51	1.12		CP5	2.58	1.04
	CD6	3.55	1.04		CP6	3.59	1.20
	CD7	4.45	1.07		CP7	3.72	1.04
	CD8	4.40	1.04		CP8	2.39	1.23
Basic quality (CE)	CE1	4.61	1.10	Learning performance (LP)	LP1	3.32	1.13
	CE2	3.75	1.81		LP2	4.49	0.94
	CE3	4.59	1.24		LP3	3.55	0.91
	CE4	3.68	0.94		LP4	3.35	0.69
					LP5	3.31	0.85
					LP6	3.34	1.14
					LP7	4.30	1.94

Table 2 An analysis on the correlation between competence and performance dimensions

Dimension	Relationship performance (RP)	Task performance (TP)	Creativity performance (CP)	Learning performance (LP)
Active assistance (CA)	0.11*	0.35**	0.06*	0.33**
Problem solving (CB)	0.45**	0.27**	0.34**	0.50**
Work development (CC)	0.38**	0.40**	0.53**	0.61**
Post comprehension (CD)	0.51**	0.41**	0.40**	0.59**
Basic quality (CE)	0.48**	0.43**	0.32**	0.57**

Notes: *means $p < 0.05$, **refers to $p < 0.001$

3.3 Confirmatory Factor Analysis

Confirmatory factor analysis is used to assess the convergent reliability of the questionnaires. There is no fixed criterion to assess the convergent reliability of the questionnaires, so, in general, such assessment will be conducted under the principles which are created by Fornall and Larcker for assessing such convergent reliability, that is to say, all the standardized factors loading will be more than 0.5. In the paper, confirmatory factor analysis is conducted on the data by Lisrel 8.0 (Qiu 2012). The results show that the standardized factors loading of all the constants and variables in the questionnaires are more than 0.5, which proves that the questionnaires are of good convergent reliability (Yin Xiguo and Xu Yan 2011).

3.4 An Analysis on the Prediction of Performance Validity by Competence

To verify whether competence indicators will effectively predict the performance of the little village official or not, the author shall test the predictions and check the correlation between competence and performance indicators (Shen Xiaomei et al. 2012).

As shown in Table 2 obviously, there is a positive correlation between competence and performance dimension indicators, which indicates performance indicators can be predicated well by employing competence dimension indicators.

From the above analysis, the questionnaires herein are applicable to the survey concerning the competence of the little village official in Suqian of Jiangsu Province, in which datas reflect a real status of such competence.

4 Conclusions and Suggestions

First, the survey herein shows that the questionnaires selected reflect an effective assessment towards competence of the little village official in Suqian of Jiangsu Province and play a remarkable role in predicting their performance (Shen Min 2011). Thus, such questionnaires are applicable to competence assessment of the little village official in Suqian of Jiangsu Province.

Second, we have a clear understanding of personal information and competence of the little village official in Suqian of Jiangsu Province through such survey. In respect of positive aspects, the little village official in Suqian is characterized with highly active assistance (CA), good post comprehension (CD) and solid basic quality (CE) (Fornall and Larcker 1981). As shown in Table 1, the average of each item under such three dimensions is all more than 3 points with narrow average standard deviation, which reflects that they have been equipped with the basic qualifications and skills as a little village official. We should also note that, however, there are many weak points in such village officials, for example, poor skills at problem solving (CB) and work development (CC), which indicates that they are not skilled at settling issues and motivating various resources (Wu 2001).

Those involved in such social practice, especially policymakers, will pay more attention to the issues reflected in the survey.

Firstly, formulate a targeted selection mechanism. In terms of policymaking, more chances will go towards the undergraduates and graduates with degrees in science and agriculture, and ration by those with degrees in management and literature will be appropriately reduced.

Secondly, make an appropriate arrangement for the little village official, making sure that the little village official meets the his/her post requirements. It will be prudent to make arrangements and changes for them in order to make sure they will satisfy the post requirements based on the analysis of the post, of their personalities and specialties.

Thirdly, set up a targeted training system for the little village official. A training system will be set up so as to help such little village officials understand the rural affairs, develop skills at communication and interpersonal relationship establishment and ability to utilize the resources on hand.

Fourthly, establish a withdrawal mechanism for the little village official. Reverse the idea about taking “acting as the little village official”, taking it as the access to becoming a civil servant, and establish such an idea being the little village official, which will be a depositing and maturing stage in personal career.

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Research of the Problems and Measures About Large Scale Employee Demission Happened in Small and Medium Sized Enterprises in Shandong Province from Human Oriented Angle

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Abstract At the juncture of reassigning social resource, small and medium sized enterprises in Shandong Province are suffering more and more demission of employees. This trend restricts their industrial transition and further development. After analyzing the problems, reasons of this phenomenon are found. From the angle of human oriented concept, eight steps to reconstruct the management system are raised. They are about human oriented concept, organizational culture, Employee Assistance Programs (EAP), reforming HR, strategically planning human capital allocation and usage, recruitment process, training system, performance management system and promotion mechanism. And a model for establishing the system is also raised, which integrates seven levels of measures with an important aid, Employee Assistance Program (EAP), as a key approach to help it work. This research result may be a reference to help small and medium sized enterprises in Shandong and in China as a whole to retain talented employees.

Keywords Demission • EAP • Human oriented • Measure • Model • Reason • Reform

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1 Background

After adopting reform and opening to the outside world program more than 30 years, China come into a juncture of reassigning social resource and reforming the reassigning system as its prerequisite. This kind of changes makes a series changes socially, among which, frequently occupational changes catch the most attention. In Shandong Province, industries of transportation, tourism and telecommunication meet more and more demission and new employment. In macroscopic view, industrial structure change, economic globalization and information globalization promote the problem. In microcosmic view, the change of concept of obtaining employment occurred among young people. With the changes continuing, the problem will go further, particularly in the relatively low competitive payment small and medium sized enterprises in Shandong. With this trend, small and medium sized enterprises in Shandong will face higher and higher demission versus employment ratio (Yu-min Qiu 2009).

2 Problem Analysis

At the aspect of operation, small and medium sized enterprises are more flexible than those big powers. They can employ and dismiss employees flexibly. This is a kind of advantages of them comparing with those big state owned companies. But a coin has two sides, since they used to employ the workers they need very soon, they don't care to retain their workers. Therefore, they don't care the high demission proportion, which would raise the cost of human resource and bring some deeply negative impact (Yan-ling 2012). Although some demission is reasonable, but for the small and medium sized enterprises in Shandong, there exist something unreasonable. Firstly, the demission versus employment ratio is too high. According to our investigation, some enterprises suffered even 35 % per year. Secondly, most of the employees who choose to leave are technical or management professional at basic level or even middle level. The thing they took is not only customers, but also business secret as well as the royalty of their colleagues who are staying. And the resetting human resource cost would be also raised. It is harmful for competence and sustainable development.

At the aspect of employees individually, low payment and bad treatment are direct reasons to resign. When a person thinks that his or her payment is not reasonable, he or she will chose to leave for a new position offer which can provide superior payment.

In fact, when the enterprises entered into stable growth period, facing to the fierce competitive market, human facts for the enterprises became more and more important (Xiao-lin 2007). Nobody can afford to neglect the point. But, they did neglect for many reasons which creates the problem.

3 Reason Analysis

At the aspect of enterprises, there are several important facts leading to the problem.

3.1 Do Not Establish the Human Oriented Concept for Their Management

The theory of human oriented thought that employees are the most important resource for enterprises. On the basis of this theory, enterprises should use reasonable way of management, consider employees' value and development as well as arrange employees work properly based on their different ability, talent, interest and other characteristics (Xiang-rong Chu 2008). However, Chinese culture and background help create a kind of actually unequal status between the leaders and their inferiors, form a kind of "control and in control" way of management, thus seriously frustrating employees for their active, initiative and creativity.

3.2 Neglect Human Capital Development

Most of small and medium sized enterprises don't regard their employees as human capital. They don't invest enough for sustainable development of their employees in order to maintain and increase their value for their work. Actually, they don't regard employees as one kind of their capital. So, using employees rather than developing is a common practice. Most of them carry out new employees training and the content of training are just for instant skills the new employees don't have. They think that developing employees costs more than recruiting new employees. In order to avoid the risk from demission of employees, they chose not to training and developing their employees further. They think that more investment, more loss, less investment, less loss.

3.3 Keep Low Standard on HR Management

After investigating about 20 small and medium sized enterprises, we found the common problems in their HR management. They are lack of scientific HR strategic planning. They are confused the concept of humanity and human relationship. They implement a series of out of date regulations to control rather than to motivate employees to work. And last but not least, they don't allocate qualified professionals to be HR manager. Therefore, although some of the enterprises realize the importance of HR management, the HR departments still do not function fully (Chao Zhang 2011).

3.4 Neglect Scientific and Efficient Payment System

Among our surveys, we found that generally, they adopt the payment way of "basic salary plus bonus" or "basic salary plus commission on sales". It used to work. But with the development and the changes of personnel structure, it lagged behind. The simple system frustrates some employees, particularly those excellent knowledge members, thus undermining the whole performance of the enterprises.

3.5 At the Aspect of Employees, There Are Also Several Important Facts Leading to the Problem

1. *Try to maximize individual economic value*.
   The developing market economy provides more space for outstanding employees. Once they find the other enterprise which has better prospect or gives them more place to develop, they will chose to leave for there. Survey shows, when a person feels that his or her payment can't reflect his or her value in work, he or she will probably tend to leave for the other who can provide more payment and more chance to embody his or her work value (Cheng-po Tang 2012).
2. *Try to find a relaxed working environment for social value*
   Many small and medium sized enterprises are family style enterprises. Outside of the relationship circle, most of outstanding employees can't fully provide talent and realize their value (Su-yan Wang and Lei Wang 2012). In order to realize their value, they chose to quit for other job offers.
3. *Try to change their way of life*
   Since more and more post-80 youth coming into the job market and gradually to be the backbone of their enterprises, most of the youth who uphold freedom tend to leave when they are facing something unreasonable. Unfortunately, the unreasonable things always appear in small and medium sized enterprises. Therefore, demission happens often among the youth.
4. *Some other reason*
   There is also somebody who is lack of career ethics, creating demission in small and medium sized private enterprises (Zhong-peng 2011). Somebody took high business secret from one enterprise and move to another enterprise to make more money.

Therefore, they need some new way to eliminate the above mentioned reasons, particularly the first three reasons in order to solve the demission problem.

4 Measures Discussion

4.1 Establish Human Oriented Concept, and Embed It into Organizational Culture

Only looking on employees as the foundation, enterprises may fully bring employees' positivity and creativeness into work, and make them fully contribute their potential, thus reaching the win-win strategy of both sides. And a kind of excellent organizational culture may put the restraint and impact function through guiding, adjusting, and motivating on the forming and developing of mentalities, needs and behaviors of employees (Jing-mei Zhang 2011). Embedding human oriented concept into enterprises culture will definitely raise the level of enterprises culture, therefore retaining talented employees by the harmonious environment created by the culture.

4.2 Introduce Employee Assistance Programs (EAP) and Embedding It into Enterprises Culture

Employee Assistance Programs (EAPs) are employer-sponsored programs designed to alleviate and assist in eliminating a variety of workplace problems (Attridge et al. 2010). It is a very useful tool for enterprises to make a better environment for employees. Environment of enterprises include hard environment and software environment. The hard environment includes the environment of work, rest and entertainment, while the soft environment for cultural and interpersonal environment (Ya-qing Ran 2012). As for the hard environment, the small and medium sized enterprises in Shandong can't compare those big powers, so placing more on soft environment is reasonable. There are two important points there. One is respect, the other is communication. The EAP focuses on these two points. So, introducing the new method is a good idea. And, according to some EAP experts, the highest goal for an EAP is to be a positive process that is embedded in the organizational culture (Beard 2000).

4.3 Attach Great Importance to Human Capital Development on the Basis of Reforming HR Department and Allocating Talented Personnel There

The concept of human capital is one of the most important concepts for entrepreneurs to accept human oriented concept. And in order to strengthen the work on developing human capital for maintaining value and even appreciating, the small and medium enterprises should make their HR department stronger firstly.

4.4 Strategically Plan Human Capital Allocation and Usage

If a company wants to follow the concept of human oriented, it should plan and perform reasonably, scientifically and systematically to employees' allocation, usage, training and development (Zhi-fei 2010). In fact, duty, power and benefit for one position in a company go hand in hand. How to deal with their relation is very important to personnel's positivity, initiative and working efficiency. The entrepreneurs and HR leader should position each job post and get to know which kind of employee suits it. Finding a proper employee is a prerequisite to retain and develop human capital.

4.5 Establish Sound Recruitment Process

After making strategic planning about human capital, recruitment plays an important role to control the demission rate, because employing the suitable persons can help enterprise use, retain and develop them. That means do not employ those people who are better than you want. It seems good, but creates high demission rate. Even the candidates are a little bit worse than you want, if they have the potential to reach the level you want, you can still employ them and make them qualified by a systematic training. Actually, enterprises have the social obligation to help their employees make progress, which embodies a sound organizational culture and may attract and retain employees.

4.6 Establish Sound Training System

It is a very important link for small and medium sized enterprises to get sustainable human capital appreciation and become more and more competitive. A sound training system for enterprises includes analyzing training demands, confirming training goal, stipulating training plan, implementing training program, controlling training program and evaluating training effect (Yue Ming 2012). And it should help reach the common staged goal of both sides.

4.7 Establish Sound Performance Management System

Small and medium sized enterprises should particularly establish a sound performance management system in order to motivate employees to achieve higher accomplishment and make more money for both sides. Firstly, establish some relation between payment and performance, which could motivate employees to work hard. Secondly, reasonably empower employees to let them function and develop. The leaders of small and medium sized should be good at empowering subordinates, let them deal with all kinds of work within the boundary of their duty range (Zhi-xun Wang 2011). Last but not least, if the employees meet difficulties in their work, this system should help them out and train them how to deal.

4.8 Establish a Sound Promotion Mechanism

No one will like to do the same work for a long time. So, establish position shifting mechanism can help the employees out and develop them. Then, some talented employees will show their talents. After doing so, position substitute system can be built up. After all, promotion system can be founded. Through these three steps, small and medium sized enterprises can foster, retain and develop their employees perfectly. Without an awesome opportunity elsewhere, no one is willing to leave this kind of company.

Last but not least, from point 3 to point 8 above mentioned, if nobody give assistance to the employees to understand the entrepreneurs' intention, all the measures will be in low efficiency. So, human oriented is not only a concept, but also a concrete activity, such as giving EAP throughout the whole HR system reconstructed. The EAP can be integrated into management skills training and other staff development efforts. It is reasonable for the enterprises to set up EAP themselves, a kind of not so typical EAP. The EAP counselors could come from HR, labor union and top management. Through this kind of EAP, entrepreneurs can discuss with each employee about his or her developing direction even at the recruitment interview, encourage employees to step forward, help them out if they met difficulties in work and give them hope to be promoted. Actually, they even don't need the overall EAP. The key function they need is only the career planning for their employees to retain them and the management skills training to develop. And it's reasonable. We may call it interior EAP.

5 Conclusion

According to the opinion mentioned above, we can form a model as followed (Table 1).

Table 1 The model for new HR system to solve demission problems

Level 7	Promotion mechanism	Interior EAP throughout the full process to help employees to progress
Level 6	Performance management	
Level 5	Training	
Level 4	Recruitment	
Level 3	Strategic plan (with EAP action plan)	
Level 2	Reforming HR department (with EAP established)	
Level 1	Organizational culture with human oriented concept	

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The Application of the Entire Human Resources Crisis Management Model in E-Commerce Company: Make Example of AZ Company

Xing Bi and Ying Liu

Abstract Chinese e-commerce market develops swiftly and violently. The choices for customers are more and more which make it an opportunity and also a challenge for Chinese e-commerce company. While as call center is core department of this industry, so to catch up with the trend and find out the rule is very important for the company to exist. The article analyzes the features of human resource management in call center. And make an example of AZ as a successful case to avoid risks by the application of the entire crisis management model during peak season. As AZ is a mature and experienced e-commerce company, how is AZ coping with difficulties may produce reference meanings for Chinese e-commerce industry.

Keywords Call center • Crisis management • E-commerce • Human resources risk

1 Introduction

These years e-commerce industry develops rapidly all over the world. I-Research consulting company found that in 2007 the B2C e-commerce sales in England were 93.2 billion according to English B2C e-commerce sales dates published by e-Marketer (Hassler and Biely 1999). In 2011 Chinese e-commerce trade amount arrived at CNY 588 million in total by the growth of 29.2 % yearly, which is equivalent to the 12.5 % of GDP. Till the end of 2011, Chinese online shopping users reached at 194 million (Winclaw 2012). E-Marketer forecast that the average yearly cost of Chinese online consumer is only 670 U.S. dollar, but from 2012 to 2016 the users of Chinese online shopping will be doubled. Till the end of 2013,

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China is expected to become the world's biggest net retail market (Schneider 2004). In China as our e-commerce industry starts late but develops very fast. A lot of troubles emerge. So it is important to grasp some rules and borrow some mature experiences to give guidance for our native e-commerce companies.

About crisis management Dewu Zhu regards it as "Crisis management is management behavior that individuals or organizations take in order to prevent the happening of the crisis, reduce the damage caused by crisis, recover from the crisis as soon as possible, or for a particular purpose to let the crisis happen in a controlled circumstances" (Dewu 2002). Jeffrey. R. Caponigro regards that "Crisis management is the natural extension of risk management. The key point is the normal and emergency event, it not only need to prepare for most factors which would lead to a crisis, but also prepare for those which look are unlikely to lead to crisis (Caponigro 2006)." Wuwei Li regards that "Crisis management is the activities of making planning decisions, dynamically regulating, dissolving and staff training which focus on handling different crisis situations (Yumei Wang 1996)."

Some scholars refer to a series of crisis management models according to crisis management experiences and theories. Augustine. R. Norman refers to "Six phases model", he divides crisis management into six phases as: Avoiding the Crisis, Preparing to Manage the Crisis, Recognizing the Crisis, Containing the Crisis, Resolving the Crisis, Profiting from the Crisis (Norman 2000). Weilun Su refers to "5 Functions" model, he thinks that crisis management includes five functions as: Crisis monitoring, Crisis precontrol, Crisis management plan, Crisis decision-making, Crisis management (Weilun 2008). These give more references to human resources management.

In e-commerce companies, call center has its own features. Comprehensive as follows: The work is monotonous and tedious; The work is repetitive; Work Pressure is high; Needs shift working time (Winston 2010). The article builds the model of entire human resources crisis management and combines the features of human resources management in call center. Make an example of AZ as a successful case to avoid risks by the application of the entire crisis management model during peak season as AZ is the world's biggest e-commerce company also is a global 500 fortune company with abundant experiences (Richard 2013). How is AZ coping with difficulties may produce reference meanings for Chinese e-commerce industry.

2 The Entire Resources Management Crisis Management Model

From the point of view of quantitative change and qualitative change, the crisis incident is a qualitative change, the crisis state is more than a certain degree of quantitative change. Before the crisis there will be some early signs of crisis, some enterprises found these precursors in advance, and take the effective measures in time to nipped it in the bud. But there are still most enterprise hasn't recognized the crisis and avoid it in time which lead to the outbreak of the crisis. So, generally crisis

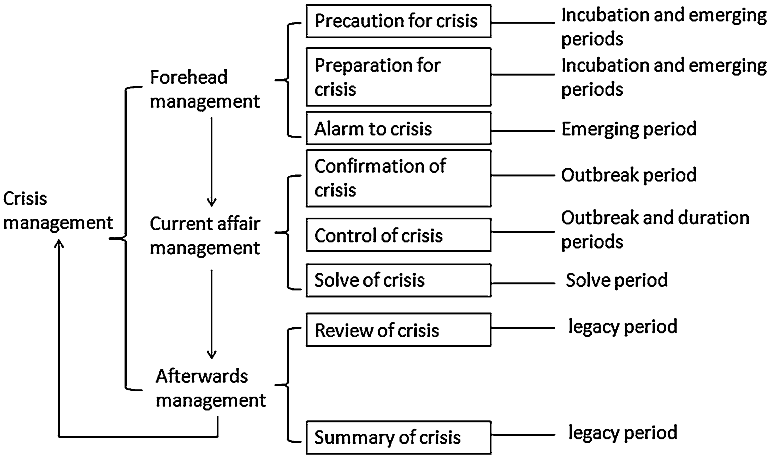

Fig. 1 The entire crisis management model

forms as: Crisis triggers—Crisis omen—Crisis incident. Also some scholars extend crisis life stages to six periods as: Incubation period—emerging period—outbreak period—duration period—solution period—legacy period.

The conception of the entire management has been widely used in many fields and generates significant economic benefits, such as the whole process management, the total quality management, the entire credit management, the staff loyalty management and so on. Simply says the entire management is the whole process management specific to objects of management (such as product quality, customer credit, staff loyalty and so on).

From the angle of mathematic the effectiveness of the entire management is as below. Suppose it needs n procedures to produce a product, the qualified rate of each procedure is $p = x$, then the qualified rate of the product is $p = x^n$. If the company want to enhance the qualified rate of the product it has two choices, one is to increase the qualified rate of some procedure to y, the other is to increase the qualified rate of the whole procedures by y/n of each. If adopt the first method the qualified rate of the product is $P_1 = (x + y)x^{n-1}$, the second one is $P_2 = (x + y/n)^n$. Simply proved that $P_2 - P_1 > 0$.

Some scholars made the crisis management model according to the theory and the application of crisis management and entire management, divided crisis management to three stages by time order: Forehead management, current affair management, afterwards management. Forehead management specific to incubation and emerging periods; current affair management specific to outbreak, duration and solution periods; afterwards management specific to legacy period. Forehead management include three functions: the avoid of crisis, the preparation for crisis and the precaution of crisis; current affair management also include three functions: the confirmation of crisis, the control of crisis, the solve of crisis. Afterwards management include the review and the summary of crisis (Jian 2003). The whole entire crisis management model is as below Fig. 1.

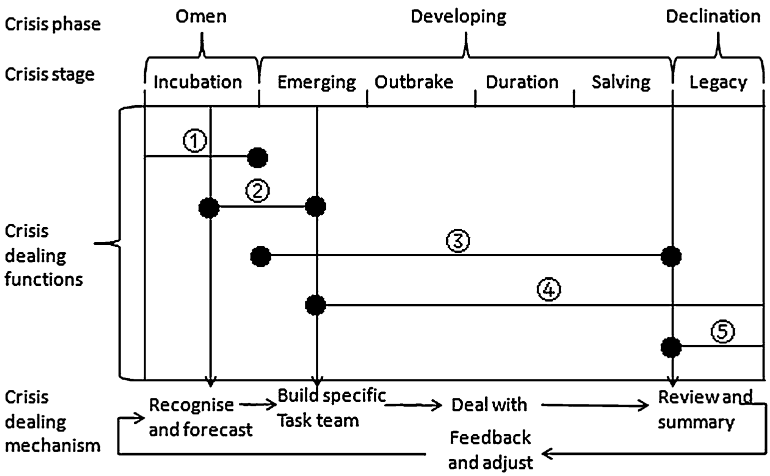

Fig. 2 The entire human resources crisis management model. Notation: ① Monitor and forecast ② Plan ③ Make decision ④ Deal with ⑤ Review and improve

Basic on the model of Entire crisis management we divide human resources crisis into three stages: Omen phase, developing phase, declination phase. With the conception of six stages and human resources management we add the management function into the coping measures as below: Monitor, plan and control, make decision, deal, review and improve. Then divide it by key point junction build the self-improvement feedback mechanism of human resources crisis management—the entire human resources crisis management model, showed as Fig. 2.

3 The Application of the Entire Crisis Model in Human Resources Management of AZ Company

3.1 Introduction of AZ Company

AZ company in China, founded in May 2000 and headquartered in Beijing, is the Chinese operation of a world's Fortune 500 company. As Chinese largest online shopping mall selling genuine products, AZ offers products spanning 28 categories with more than 2.6 million items (Limei 2010). AZ is determined to provide the best online shopping experience to its Chinese consumers, including services such as free shipping and cash on delivery. AZ has maintained steady, strong growth over the past few years. The size of its customer base has also grown significantly. AZ company has 14 operation centers and two call centers in China. The two call centers support all workload of the whole operation line. In the past 2 years AZ experienced

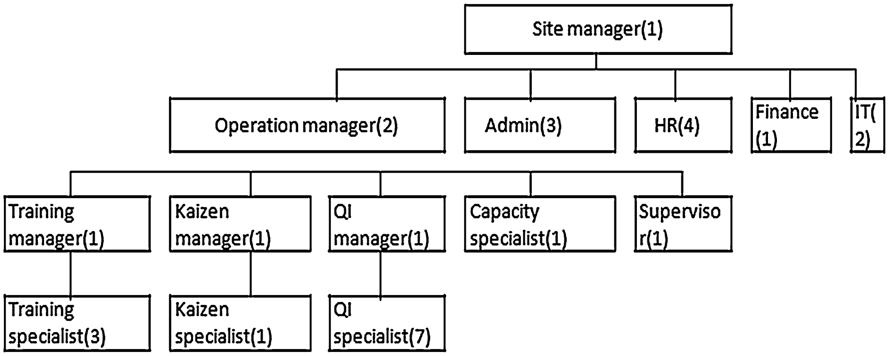

Fig. 3 Organization chart

serious human resource management risks during peak season. While here make an example of one call center to make detail description for how they avoid risks during peak season with the application of the entire human resources crisis model.

3.2 The Call Center Basic Description

In AZ company there are “Ops” and “Support” two main lines for partition staff. Department setting is shown in the Fig. 3. Ops line means the group related to business directly. Support line subjects to customer service specialist and related department which solving doubts, supervising performance, improving working quality. Such as training department, quality department, kaizen department and so on. While the other line is the department supporting service for the staff in the field which has no directly relation with business such as HR, Admin, Fin and IT support department. And now there are 335 heads totally and 325 heads is in operation line, only 10 heads in support line. While the staff number in basic line is 277, in management level is 58. The ratio of basic level is 82.69 %. By this we can see that in this call center customer service specialist occupied the most part of all staff, so how to make them satisfied with the work is very important for the stability of the site.

While in the group of CSA the percentage of female is 77 %. Compared with male staff, female may request for more time accompany with family and going shopping, and also female care more about the balance between work and daily life.

As e-commerce industry is a young one in China and the main customer group is very young. In the whole call center, 90 % staff are 80s and 90s (Level 1997). Compared with other age group they are more freestyle and full of characteristic. They don’t hesitate to embrace new things, creative ideas, facing challenges.

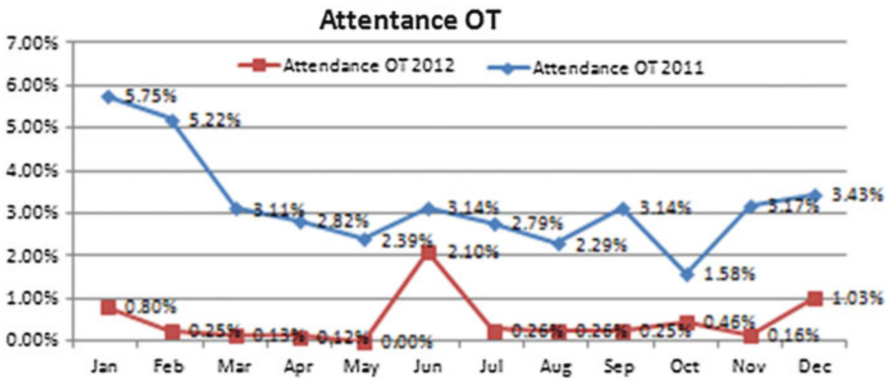

Fig. 4 Attendance OT

About education background, 30.43 % is bachelor degree, 48.31 % is junior college degree, tertiary is 21.26 %. This reflects that in the call center basic position most of the employee is in a lower education background. The initiative and positivity may be easily influenced by the environment.

3.3 Human Resources Crisis in 2011

During peak season the spurt volume of business lead to more workload, so the attendance OT is higher than normal days. By detecting the date of attendance OT in 2011 and 2012, we can easily find that the ratio is higher between Nov to Feb. As shown in the Fig. 4. While in June there is also a small peak of attendance OT. This may be aroused by season shift. But generally the trend is higher than usual.

By detecting sick leave data, we found that the highest record present to Feb by 1.88 %, while the second sick leave peak is in December by 1.38 %. Obviously the rate is higher at peak season than usual. As shown in the Fig. 5.

While about attrition rate it is obviously higher than usual in peak season. In 2011 at worst condition the rate reached at 26.76 % in March showed as Fig. 6.

The development process of the crisis and the coping measures is as Fig. 7. In the chart we can see that during the peak season time of 2011, the company did a bad reaction to the sudden human resources crisis. That's called "emerging-action" model which means that when the crisis comes and we make a action. Certainly it's a relatively ineffective method to solve the problem though it made a small improvement.

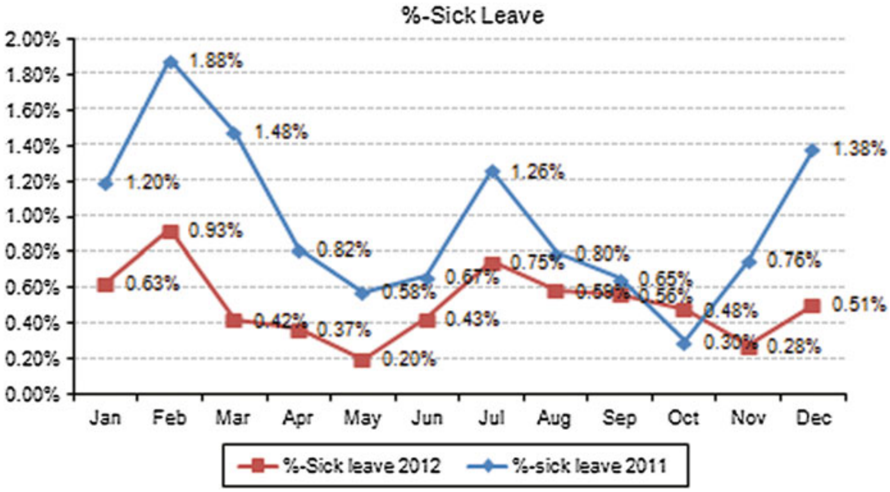

Fig. 5 Sick leave rate

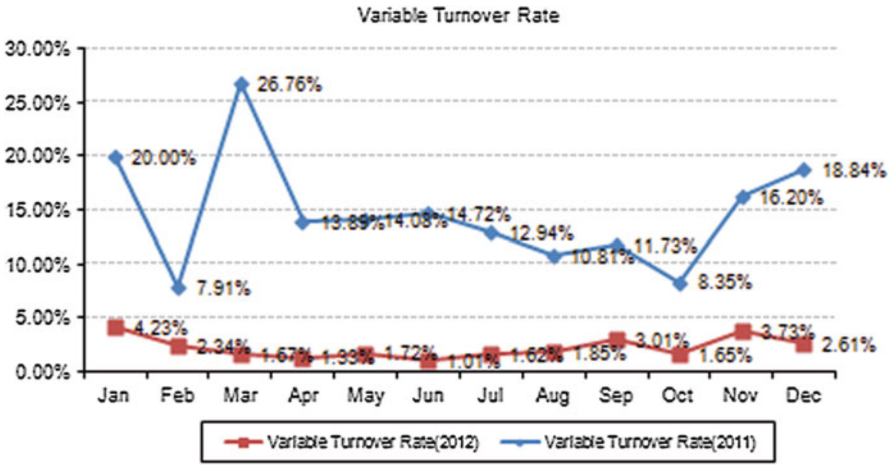

Fig. 6 Variable employee turnover rate

3.4 The Application of the Entire Human Resources Crisis Management Model Made an Improvement in 2012 in AZ

Experiencing the big crisis in peak season of 2011, the HR department made a progress in human resources management in 2012 with the entire model and released a series of measures to prepare and code with the peak season crisis.

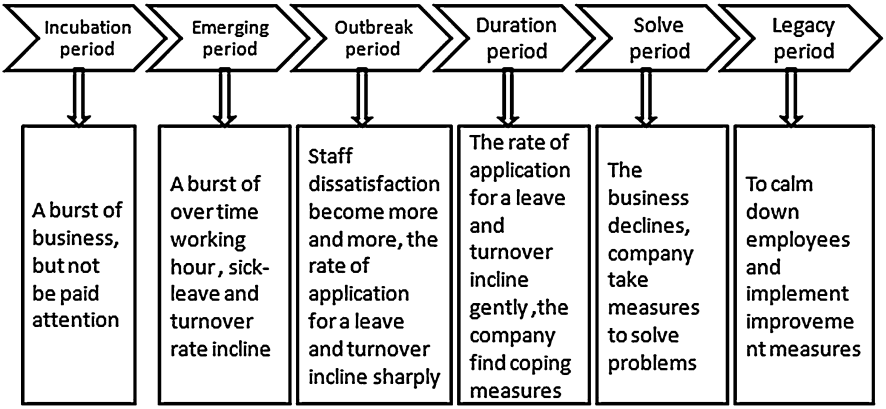

Fig. 7 Emerging-action model

At the first omen period of the crisis (1 month ahead of peak season) they made an "Associates Insight Survey" plan to know deeply and widely about what their employees focus on and how they fell about the work load. This project has three purposes. First to regularly assess labor vulnerability, second to improve employee morale and trust, last but not least was to identify key priorities for improving work environments and sustaining strengths. By this project the managers knew more about what the employees were really most concerned.

During crisis developing period. The HR Department build a special task team to cope with the crisis. They made a short-term talents recruiting plan to add labour counts by the means of hiring a batch of employees which would be working only for 4 months as customer service specialist. They also made a series of decisions to deal with the crisis step by step. They improved the incentive measures by building "Score bank" plan which is a innovative performance evaluating project. The plan added more index to value staff performance such as club activity index, creativity index and so on, and the end of the month the employee can exchange the score with a present except money. This made the working monotonous reward method to be a vivid and interesting one. And created a more comfortable working atmosphere as they may feel that the company care of them more than performance (Junqiang Wang 2006). While during peak season they also released more abundant humanistic care activities for employee, such as on festival and holiday provide free drinks and food for the employee on duty. Fund more fun club such as football club, dancing club, Yoga club, Knitting club, Reading club, Video club and so on. In one club there will be a leader and he will be organize activity regularly at working time as each member may have 2–3 h free time for having fun with salary. It's a really kind of combining of working hard and having fun. They even invited psychological guidance for employees during peak season to dredge negative emotion produced by working load which have been said as an effective way to improve performance in call center (Mary 2005). These methods enhanced associates satisfaction and declined turnover rate during peak season in 2012.

At remnant period, the special task team made a self check by meetings and questionnaires to review the effect of the pleasures and to make an improvement project for the neat season time. By these steps a benignant circulation formed.

4 Summary

In conclusion, Peak season is a relative new concept in e-commerce industry. Some company had no realize of it and always experienced sizable crisis even deadly. AZ is a good teaching material for most Chinese e-commerce industry in dealing with peak season human resources management crisis. While at the same time the entire human resources crisis management model has been improved an effective model to cope with human resources management crisis in peak season. Now Chinese e-commerce market is developing gradually. It's an opportunity and also a challenge. Expert forecasts that in the next few years there will be piles of e-commerce company bankrupt. So catch the rule of the industry and keep the steps are very important. Hope the model can support guidance and reference meanings for Chinese company.

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Pay for Competencies on Broadbanding Platform in Human Resource Development

Man Huang and Gui-long Zhu

Abstract Competency-based pay refers to a form of human resource strategy that allows organization pay for employees' ranges, depths, and types of skills and knowledge, rather than for the job title they hold. With the integration of the world economy and the rapid development of business, considerable amount of organizations are using competency-based pay model. In this study, pay for competency in broadbanding platform is examined through the pros and cons, and which aims to provide practical strategies for effective management for implementing human resource strategies.

Keywords Broad-banding • Competency • Human resource strategy

1 Introduction

With the increasing competition in the business world, organizations are confronted with more pressure on adding value, attracting and maintaining multi-skilled workforce, and adapting more flexibly to the volatile internal and external environment. Based on different organizational culture and background, different organizations take various measures to handle the pressure, among which 'the quality of the human or intellectual capital possessed by organizations is seen generally as the key factor in differentiating them from their rivals and achieving superior results' (Armstrong 2002). As described by Tucker and Cofsky (1994), most organizations

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probably have tried at least one of the new wave of human resources strategies that have made a splash in the marketplace in recent years. During the process, organizational and individual competencies attract more and more attention based on the assumption that individual development contributes to the 'core competencies' and help highlight the competitive advantage (Flannery et al. 2010). After a number of approaches to competency-based pay have been tried, one combination-competency-based pay on a broadbanding platform-appears to stand out in its ability drive performance in a change-oriented environment. As a means of structuring base pay, competency-based broadbanding has irreplaceable strengths. Although competency-based broadbanding is considered by Bennett (1994) as 'one of the most powerful and effective strategies available to organizations today', it should be noted that competency-based broadbanding has its own weaknesses as well. This paper mainly deals with the strengths and weaknesses of competency-based broadbanding and in the end try to put forward some recommendations to minimize the effect of weaknesses and maximize that of the strengths.

2 Competency-Based Broadbanding: Some Cases

A large number of organizations may share the similar experiences that Bass PLC experienced in 1990. As described in Flennery et al.'s book, when Bass PLC acquired Holiday Inn's North American operation in 1990, it found that the hotel group lacked an aggressive service-oriented culture. It needed employees who were not only skilled, but also energetic, service-conscious, problem solvers. It was later found that the solution lay in the development of not just the traditional, technical skills employees needed to successfully complete their jobs, but also in a number of less obvious competencies—such thing as the ability to work in teams, to accomplish specific goals, to solve problems rapidly, and to understand the customers' perspectives and meet their needs in a way that really added value.

In today's competitive environment, many companies, like Campbell's Soup, come to realize the success no longer merely relies on quality of products; instead, they need to explore a larger stock for creative, capable talents and professionals which can show employees' long-term and updated acquisition of new skills and competencies. Due to the existence and development needs, competency-based pay model is adopted and developed within some companies. People are rewarded wholly or partly for the level of competencies they demonstrate in carrying out their roles (Klaas 2002).

While transferring to competency based compensation strategy to encourage people to develop both higher level and wider scope of competencies, another indispensable issue facing organizations is how to move people through the organization. When flexibility and maneuverability needs to be provided simultaneously for the strategy, the traditional towering career ladders with rungs upon rungs of potential upward movement, have in essence, been pared down to a stepladder

(Abosch 1998). Broadbanding, which provides a platform on which competency-based compensation strategy can be built and operated, has gained popularity since last decade (Abosch and Hand 1994). By reducing the number of bands, people are slotted into a certain zone within a certain band, and then moved within the zones and bands according to their level of competencies, and more practically speaking, to their demonstrated utilization of competencies.

One of the documented examples of adopting competency-based broadbanding is General Electric, which collapsed 27 levels and grades into just 5 bands. Based on competency growth, and with an eye toward the market, people move through the bands based on their demonstrated utilization of competencies. This demonstration is assessed via a 360-degree appraisal in which supervisors, peers, subordinates, customers, and the employees themselves rate their competencies and performance. Like General Electric, more organizations move towards flatter structure with more emphasis on lateral career development (Armstrong and Brown 2001), and as one means of structuring base pay, competency–based broadbanding provides a comparatively effective platform for compensation strategy, and its strengths and weaknesses will be discussed in the following section.

3 Implementations of Competency-Based Broadbanding

3.1 Overall Merits of Adopting Competency-Based Broadbanding

Adoption of competency-based broadbanding may create a win-win consequence for both organizations and employees. Particularly for the organizations operated in a flatter structure, which focus more on flexibility, teamwork, and personal career development, this strategy, on one hand, facilitates organizations with flexibility, increasing acquisition of valued competencies, reduction of administrative complexity, decentralized management. On the other hand, for employees, more opportunities for progressing in pay and career development will be provided.

3.1.1 Flexibility

A 1998 survey sponsored by ACA indicates that flexibility is the first reason for organizations to use broadbanding (Abosch 1995). While adopting competency-based broadbanding, the greatest strength organizations would gain is flexibility. As far as the structure is concerned, usually there is no midpoints, even no reference or control point which is used as a basis for the traditional graded structure. Pay zones provide managers with guidance in making pay decisions, and ‘it is possible for employees to be paid outside the zone without the need for special approval or job evaluation’. Therefore, instead of climbing up through a series of grades, employees might move laterally, that is to say, employees may spend their careers in a single band, but get more pay as they gain new competencies or accelerate their demonstration of competencies. Besides, unlike traditional pay grades, bands do not have to be constructed “end-on-end”, but can be designed to overlap, thus adding flexibility to an already flexible pay program. The overlap recognizes one people in one band may deliver more added value than some in the next higher band. For example, it is possible for an employee may progress to get higher pay than the employee’s team leader without elevation to another pay range or job title, which would never be allowed within traditional graded structure.

All the flexibility created by competency-based pay contribute to reducing the hierarchical complexity and administration burden, which pose as obstacles for the establishment and development for flatter and less bureaucratic organizations.

3.1.2 Reduced Hierarchical Complexity and Administration Burden

During the implementation process, since more jobs are grouped together and employees are evaluated and paid on the basis of their competencies, they may move across functions and different levels, the role of hierarchy may be reduced in an organization (Klein 1996), accompanied by the reduction of administrative complexity and administration burden created by the complexity (Doug Davies 2002). One advantage is that it will bring about higher efficient operation. For example, as there are few levels of pay between distinctions that needs to be made, time spent in analyzing and evaluating jobs is reduced. Besides, since true competencies are those that add value and help success, competency-based strategy focuses more on how individual competencies will incorporate into corporate competencies, and what competencies are or will be utilized to achieve the organizational strategy rather than on merely what employees have achieved. These highlight the alignment between organizational strategy and individual development, and also help achieve the maintenance and evolution of organizational culture. Take the above-mentioned Electric General for example: when the broadbanding program has been very successful, it has helped the organization successfully transform its culture, shifting importance away from individual organizational rank to the value employees actually create.

3.1.3 Breaking Class Distinction

Another advantage is through the devolution of more responsibility and accountability to line managers. When competencies-based pay is implemented on a broadbanding platform, the “walls and class distinction” between employees and managers is broken down. When managers are empowered in such areas as evaluation process, salary budgeting, since people are paid and progress according to the value of their competencies within the organization without need of climbing up the hierarchical graded mechanism, it will create a less tense environment for employees and managers, with more opportunities for communications and teamwork being available.

3.1.4 Rewarding Employees

For employees, competency-based broadbanding enables organizations to reward for the continuous learning and the achievement of increased levels of competencies. Today, organizations compete with each other on the stock of professional talents and the related corporate attributes. Therefore, the last thing an organization wants must be for its employees to ‘balk at taking a new assignment or learning new competencies because they are afraid it might negatively impact their title, grad, or pay’ (Parus 1998). Implementation of competency-based broadbanding frees employees from the set of prescribed duties in a stable job, and distracts their attention away from the vertical promotion. They are motivated to carry out dynamic roles which competencies counts a lot for determining what they do as well as how they do it. Consequently, to achieve higher recognition and pay as well, employees focus more on individual development of competencies, especially those that are aligned with the organizational strategy and culture. In this way, personal development and self-satisfaction can be gained for employees on a fairer level and thus promote individual competition edge in the labor market.

3.2 Overall Demerits of Adopting Competency-Based Broadbanding

However, as a means of structuring base bay, competency-based broadbanding has its own weaknesses, which during the implementation, deserve special attention and under some circumstances, weaknesses may even outweigh strengths.

3.2.1 Limited Room for Validity and Efficiency

Although much strength exists within broadbanding structure, it should be noted that it is not a best practice which fits all organizations. Many companies, like General Electric, have reported excellent results with the approach. But an in-depth study sponsored by ACA and conducted in late 1993 and early 1994 by Hewitt Associates LLC showed that there are still some companies that discontinued or failed in the broadbanding platform. Competency-based broadbanding just works within certain type of organizations. To be specific, the competency-based broadbanding strategy is only valid and efficient when it fits the existing organizational culture and is implemented in a way that supports organizational strategic goals. As presented by Armstrong and Brown, broadbanding is most likely to be appropriate when de-layering has taken place, the focus is on flexibility, teamwork, multi-skilling and cross-departmental processes rather than vertical, functional ‘chimneys’, and when the platform is conducted with emphasis on employees’ level of competencies, the incorporation of individual competencies into organizational strategies, even daily operation. For example, if a company plans to introduce the broadbanding strategy, it should be checked first whether some basis like competency frameworks and profiles are available and have been valid for a period.

3.2.2 Complicated Organizational Structure

By eliminating grades into several bands and focusing on paying people for their competencies, competency-based broadbanding seems to simplify the pay structure and hierarchical administration. But when implementing it, organizations may face the increasing difficulties in defining competency dimensions and measuring them as well as determining the width of bands and scope. In fact, it is not only difficult to design but also hard to introduce and manage.

Judging individuals according to the demonstration of competencies is a difficult task. It requires an organization to exactly identify the competencies that create value for the organization, and thus should be rewarded, rather than just create a general list of competencies defined by academic works or by a certain advocate. Furthermore, to attract and maintain a high-quality workforce, it’s reasonable to maintain a link to what other companies pay for similar level of competencies, which is needed for the establishment and pricing of the competency zones. However, most compensation surveys still focus on the payment of jobs, not people or competencies. Organizations will find it hard to handle the pricing procedure because of lack of sufficient market rates for comparison and reference. Besides, how to explain to managers and employees how the system works and how their pay will progress are more difficult than the traditional graded structure. Overcoming these difficulties require not only great efforts, but also vast consumption of time and investment (Lubit 2001).

3.2.3 Perceived Unfairness

It is stressed that although competency-based pay might be considered as a means of achieving more equity on a broadbanding platform, ‘it may actually increase incidents of perceived inequity’. The competency-based structure is based on competencies as the traits of individuals, and as mentioned above, competencies are actually difficult to identify and sometimes hard to observe, more potential for subjectivity may emerge. Besides, the broadbanding platform allows more freedom for line managers to make their own pay decisions, which may mean ‘a return to the bad old days of management favoritism, subjective judgments and inequities’ (Tyson 1995). This is more likely to happen when there is a lack of introduction and guiding procedure for employees and managers.

The changes brought about by competency-based broadbanding may not only lead to more potential for unfairness incidents but also perceived threat for employees. For most of the time, title has become part of a person's identity, a code for status and success. The removal of grades caused by competency-based broadbanding, for some employees, means giving up titles which they may value a lot and also restricting the promotion opportunities. Therefore the implementation of banded platform, while motivating employees to develop personal competencies to some degree, may also contradict ably de-motivate employees, and even generate resistance towards the introduction and implementation of competency-based broadbanding structure, thus achieve even lower efficiency than traditional pay strategy (Barney 1991).

4 Conclusion

Broadbanding has gained popularity since last decade (Bennett 1994), and implementing competency-based broadbanding as a means of structuring base pay may bring about more flexibility, improve efficiency, contribute to organizational goals, culture and motivate individual development. However, its weaknesses should never be omitted, which may frustrate the general aim of fitting de-layered organization structure and rewarding people for lateral development if competency-based broadbanding does not correspond with the corporate culture and existing structure and strategies. So it is not right for all organizations. And to fully utilize its strengths while trying to conquering the weaknesses, support mechanisms such as careful introduction and implementation plan, sufficient communication, supporting program for competency development and objective evaluation of overall effective of pay strategy needs to be provided.

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To Construct the Human Resource Management System with Competence–Based on the Certified Public Accountant Industry

Shao-li Qi and Hong Yue

Abstract The Certified Public Accountant (hereinafter referred to as CPA) industry is a special industry which is people-oriented and intelligence intensive. The industry is growing stronger and bigger, new businesses are expanding wider, and information technology is developing faster. With the above background, CPA firms are facing more intensive competition for talented people. CPA firms should pay more attention to establish an effective human resource (hereinafter referred to as HR) management system in order to attract and retain talented people. Focusing on Chinese CPA qualification examination, the CPA profession including age structure and education background, and professional quality, this paper analyzes the present HR status of CPA industry, sums up the existing problems about HR management and finally proposes the countermeasures for HR management from the perspective of CPA firms.

Keywords Certified public accountant firms • Competence • Human resource management • Professional quality

1 Introduction

CPA (hereinafter referred to as CPA) industry is a kind of intermediary industry in which CPAs provide assurance services for enterprises' accounting information or business services such as accounting, tax and consulting by using their special knowledge. The CPA industry is an important part of the socio-economic system of supervision, and also an important force in the modern service industry. It is becoming an indispensable part for promoting a healthy economy. CPAs provide

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professional services for different enterprises, so human resources are of the first element in the industry. During more than 30 years of development of the CPA industry, personnel development has made considerable progress, especially with the implementation of talented people cultivation strategy. With higher demands for talented people to provide service for the fast growing economy and social development, the present quality of industry talent is difficult to meet the diversified development needs. As some CPA firms have no effective internal governance mechanism, or the incentive and constraint mechanism, human resource (hereinafter referred to as HR) management faces a number of problems, especially the loss of the backbone in some Chinese areas.

Some scholars study the problems and strategies of HR management in CPA firms from their points of view. First, Yu-gui Chen (2008), Dao-qin Han and Tian-ren Qu (2010), Zhi-hong Sun and Bing Lu (2010), Dao-qin Han and Xiang-jun Lu (2012) discussed talent cultivation of the CPA industry. Second, Xiao-ju Li and Chun-hua Mao (2003), Yue Tu and Li Yan (2006) summarized the characteristics of HR in CPA firms. Third, Ying Guo, Yan-shu Wang (2005) analyzed different influence factors of HR management. Fourth, Ming-yu Zhang, Xiao-qian Mao (2005) pointed out some problems of HR management. Fifth, Li-ping Wu (2006), Ming-yu Zhang (2009), Hui-ting Chen (2011) suggested related improvement strategies.

In recent 5 years, scholars' articles of HR management in the CPA firms are not particularly rich. The Chinese CPA industry is developing fast, which needs a great number of talented people. There are some problems facing the CPA industry, including the ignorance of the role of HR Management, lack of appropriate HR system and mechanism and inadequate team culture. This paper will discuss how to build the HR management system of CPA firms focusing on the CPA competency.

2 Status of HR in the CPA Industry

2.1 Qualification Practice for CPAs

Chinese CPA system was established in 1918. At the early stage of New China, CPA industry was interrupted due to the implementation of the planned economy. After the third Plenum of the Eleventh Party meeting in 1978, CPA audit returned gradually in order to adapt to the development of socialist modernization. In December 1980, the Ministry of Finance issued the "Interim Provisions on the Establishment of Accounting Consultants", which indicated the recovery of CPA audit in China. Restoring the system of CPA must solve the problem of personnel development first. The qualification practice of Chinese CPA industry has gone through three stages.

The first stage is the selection stage of assessment. "The Interim Provisions on the Establishment of Accounting Consultants" stipulated that CPA qualification was to be granted by assessment from the existing accountants or senior accountants. The assessment selecting method is adapted as an emergency measure to restore the shortage of CPA professionals. The selecting method has played a positive role for the CPA profession to service economic development, but disadvantages existed. Hong-wei Cheng (1998) mentioned "the CPA team both in quantity and quality has many problems, such as the aging structure, obsolete structure knowledge, quite low professional moral level."

The second stage is the stage of assessment and examination coexisting. Released in July 1986, "the CPA Ordinance of China" stipulated a combination of examination and assessment for CPA qualification. But the unified national examination time was not ripe, so qualification of CPA depended on the assessment in 1980s. The implementation of a unified national CPA examination system started from 1991 in China.

The third stage is the examination selection stage. Released in October 1993, "the CPA Law of China" clearly stipulated that the selection of CPA was to adopt the examination system, and to abolish the assessment system. After constantly reform and perfection, the CPA exam has become the important personnel support for the development of CPA profession. But in the course of many years of operation, the CPA examination system also shows some shortcomings in personnel selection. For example, Rui-lan Guan (2007) pointed that "the exam focuses only on the theoretical knowledge rather than the actual practice and the competence to practice." Suzhen Chen (2009), Ling-li Lu and Chang-ai Li (2010), Su-qin Yuan (2012) have expressed their own opinions to further improve the CPA examination system. The new demands from the international development and the new situation in the process of socialist market economy require the selection and training of the CPA professional to improve a lot. So the reform of CPA qualification system is imperative. In January 2009, "Chinese CPA Examination System Reform Program" was issued, which aimed at establishing the CPA examination system in line with the concept of life-long learning, and fully reflected the competency evaluation requirements of the industry. The examination system reform involves the examination stage, the adjustment of the subjects and the valid period for grades. At the same time, the examination method, frequency and other controversial issues are not addressed.

The CPA exam is now divided into professional stage test and comprehensive stage examination. The professional stage of examination includes six subjects, namely account, audit, financial and cost management, corporate strategy and risk management, economic law, taxation law; comprehensive stage examination includes one subject, namely comprehensive occupation ability test. The qualified scores for the first stage is valid in 5 consecutive years. The second stage of the examination should be completed within 5 years after obtaining the certificate after the professional stage. The professional stage test aims to test the examinees whether have necessary knowledge, grasp basic skills and professional moral requirements. The comprehensive stage aims to test the examinees whether apply knowledge in the practicing circumstance, whether keep professional values, attitude and moral, whether solve business problems effectively.

By 2012 there have been 21 times of examination held since 1991. The CPA exam has become one of the prestigious examination in China. According to the industry management information system of the Chinese CPA, up to December 31, 2012, there are 8128 CPA firms, 99,085 practicing CPAs, a non-practicing member of 98,089 people. Currently CPAs across the country are more than 25 million people (including qualified but not yet membership staff).

2.2 The Age and Education Structure of CPAs

The Chinese Institute of Certified Public Accountants (hereinafter referred to as CICPA) has announced the name and information of the top 100 CPA firms for 10 years since 2003. Those information allows the community to a comprehensive understanding of the development of the industry to determine the comprehensive strength of the firm. CICPA amended the "Measures for Comprehensive Evaluation of the CPA Firms" in 2011, which extends the original five indicators to 365 specific ones focusing on four categories including business income, the number of CPAs, the comprehensive evaluation of practicing quality, penalties and disciplines. From 2003 to 2005, and 2008 to 2010, the announcement of the top 100 CPA firms contained the age and education, while no information was disclosed for other years. Specific information is as shown in Table 1.

Based on the published information about age and education structure, we know that more than half of CPAs from the Top 100 accounting firms are between 30 and 50 years old or under 40. CPAs with the bachelor's degree account for more than 50 % of the total number, while the number for those only having college degree are declining, master's degree increasing gradually, percentage for PhD almost no change. In order to provide high-quality professional services, CPA industry must rely on the excellent professional quality, the competence and the ethical standards.

2.3 Professional Quality of CPAs

In the course of their practice, CPAs should maintain due professional care. Following the professional standards and ethics, CPAs could guarantee the quality of services. Any breach of contract, negligence, fraud, CPAs should bear the consequence in accordance with the relevant laws and regulations, either administrative responsibility, civil or criminal liability. From 2001 to 2012, China Securities Regulatory Commission (hereinafter referred to as CSRC) announced its punishment for CPA firms and CPAs in its official website. The punishment records are 34 and 82 people involved. The type, number and proportion of punishment are as shown in Table 2.

Among all the punishment announced by CSRC for violation of the relevant laws and regulations, 34 cases can be divided into three types. First, the violation

Table 1 Age and education structure of top 100 CPA firms from 2003 to 2005 and from 2008 to 2010

		Age			Education		
Date	CPA number	Under 30 (%)	30–50 (%)	Above 50 (%)	Master and up	Undergraduate (%)	Others (%)
2003	9 900	26.37	54.89	18.70	4.71 % (PhD 0.21 %)	51.16	44.13
2004	11 562	17.34	60.95	21.71	4.55 %	51.39	34.06
2005	11 287	15.81	67.48	16.71	4.79 %	54.27	40.94
2008	17 152	17.70	68.84	13.46	8.87 % (PhD 0.40 %)	60.96	30.17
		Age			Education		
Date	CPA number	Under 40 (%)	40–60 (%)	Above 60 (%)	Master (%)	Undergraduate	PhD and up (%)
2009	19 748	70.87	22.85	6.28	9.25	90.34 % (college 29.18 %)	0.41
2010	23 124	69.15	24.51	6.34	10.47	89.11 %	0.42

Table 2 Type of punishment

Type	Amount	Percentage (%)
Warning	14	17.07
Fine	43	52.44
Warning and fine	15	18.29
Fine and suspension of license for 6 months or 1 year	6	7.32
Fine and suspension of practicing for half year	1	1.22
Over retrospective period	3	3.66

of the professional ethics of CPAs and failure to maintain due professional care. Second, violation of professional standards of the CPA, specifically: the purpose of the audit is to avoid the company to be delisted from the security market which deviates from the financial audit objectives; Failing to follow audit procedures, or following the procedures incorrectly; No effective alternative procedures, no audit plan, no arrangement about group discussion, failure to control audit risk, or no appropriate analytical review work. Failure to obtain sufficient appropriate audit evidence. Third, violation of the stipulation about saving and borrowing of audit working papers, no signature and review comments on the audit working papers, no effective implementation of the three-tier review system, and signature is not signed by the CPA appropriately.

As can be seen from the above analysis, after passing the qualification examination, if the CPA doesn't practice with due diligence in the course of their practice, or lack of professional competence, Vor cannot fully comply with ethical requirements, there will be some irregularities. With the present personnel admittance mechanism, the CPA firms are responsible for the training and management of CPAs. CPA firms should establish relevant mechanism as to the recruitment personnel training, evaluation, internal promotion and income distribution to improve the practicing ability of certified public accountants.

3 Problems About HR Management of CPA Firms

3.1 Ignorance of the Role of HR Management on the Course of the Development Strategy of the Firms

Some CPA firms still put more emphasis on personnel affairs, ignoring the combination of the firm's development strategy with HR management. If the accounting firms are still in the initial stage of HR management just like above, they may not meet the strategic needs of development. For example, if they lag behind in the aspect of high-level international team construction, it is difficult for the firms to meet other high-end financial and international business needs; If they have insufficient number of specialized personnel to be able to service the special business, or their professional service capacity is limited, it is difficult for the firms to meet the needs of industry diversification. The human resources department should have a clear understanding of their goals, mission and strategy, put more emphasis on development, and make their job enjoyable by incentives and evaluation, to reach the goals of the accounting firms.

3.2 Lack of Appropriate HR System and Mechanism

Only the sound human resource system and mechanism are established, can the core competitiveness of the firms be enhanced. HR department should have be clear about human resources policies and development procedure, recruitment and dismission. The competition in CPA industry for talented people is fierce, so sometimes, accounting firms tend to relax the recruitment conditions, while put more emphasis on the assessment of professional knowledge or the amount of clients and ignore the moral level or practical skills. There is no scientific index system to evaluate the performance of the recruited, that is to say, however your work is done, there is no difference, which would surely hurt the talented people's initiative and enthusiasm seriously. In addition, CPA is a kind of profession which provides high intelligence service, so how to make the employees to maintain the competence is the key problem for each firm must to consider. Good firms respect the laws of the growth of talent, and provide the necessary training and follow-up education programs. But it is undeniable, those firms with mismanagement is short-sighted in staff training, which results in lack of competence and thus bounds the development of the firm.

3.3 Lack of the Team Culture Resulting in Brain Drain of Core Backbone

Unable to retain talented people is the most prominent problems facing the accounting firms. Many college undergraduate and master's graduates find their first job in an accounting firm, but they leave the firm with experience a few years later. The important reasons for CPA staff high mobility are: With the fierce competition, if they found out no hope for promotion, then they will choose to leave; the work is hard and they have to shoulder the pressure of long working hours caused by working overtime or travel. Because the internal governing mechanism and incentive mechanism are not perfect, CPAs are difficult to feel at ease in the firm. The root cause of the "Big Four" CPA firms to attract talent lies in that its unique firm culture can influence human resource policies, and that they build an elite team with reasonable structure, clear division of labor, and running effectively. It can be said that it is because they have excellent personnel, their core competitiveness improves constantly, they could keep the long-term advantage for development.

4 Improvement of Strategies of CPA HR Management

4.1 Building the Human Resource Management System with Competence

Based on “Guideline on the Competency of CPAs” (hereinafter referred to as Guideline), competence means that a CPA is able to complete tasks in accordance with the standards set in the practical work environment based on professional qualities. Professional qualities include professional knowledge, professional skills, professional values, ethics and attitude. For a CPA in different professional level, professional quality is different and needs to be nurtured through lifelong learning, and to be maintained and improved. CPA firms should reform the existing HR management system, innovate personnel training and development mechanism according to the ability standard mentioned in the Guideline, to further enhance the cohesion of the team. Building a HR management system with competence consists of three core components. First, to establish personnel competency standard system. CPA firms determine their specific competency standards based on Guideline, combined with their business category, job requirements and the different stages of development. Second, to establish the obtaining and maintaining system of personnel competence in CPA firms. CPA firms should focus on the obtaining and maintaining of competence to establish internal training system, specifically including pre-job training, continuing education and career development as the main content. Third, to establish personnel competency assessment system. The firms should focus on employee ethics education, professional competence to keep their career development, and emphasize the practicing integrity.

4.2 Establishing a Sound HR Management System and Mechanism

Good HR management system and mechanism is the fundamental force to realize development strategy. The set of system and mechanism is helpful to optimize the structure of HR, realize the rational allocation of human resources and layout, give full play to the role of human resources, and strengthen the incentive mechanism. In short, the set HR system and mechanism can make every employee involved in accounting firms’ sustainable development.

CPA firms should improve their internal management, establish a sound, strict, reasonable and transparent human resource management system and mechanism to prevent the brain drain. First, HR department and the business department make out recruitment plan, determine a reasonable allocation of human resources together, arranging the personnel structure reasonably. Second, firms should organize human Resources with consideration of the whole firm. According to the project's complexity and workload, the firms arrange the project participants and the time reasonably, to make sure that the staffs involved have the proper professional competence, and to ensure the communication among staff members is smooth. Third, to establish a quality-oriented, scientific and reasonable employee performance evaluation system and reward system. Make the employee performance evaluation criteria, evaluation procedures and requirements clear, and fully mobilize the enthusiasm and creativity of all employees; Employee performance evaluation criteria should be covered the following factors including the quality of the staff practicing, work intensity, work efficiency, work attitude, work ethic, professional competence and ability to market development, completion of the training conditions and other factors. Four, to establish a performance evaluation system combining the system of remuneration and promotion. Combine the responsibility with remuneration, material rewards with spiritual incentives; support employee growth and development, and establish a promotion mechanism matching the development strategy of the firm, market development and quality control.

4.3 Emphasizing the Corporate Culture in Accounting Firms

The practicing quality of CPA firms does not depend on individual excellence but on the cooperation and efforts of the team. Enterprise culture construction is useful to promote good team building. Therefore, the HR management of CPA firms should focus on how to build a good team. The firm should nurture the spirit which reflects their own unique vision, positive values, honest and trustworthy philosophy, fulfill their social responsibilities and pioneering innovative spirit, and nurture awareness of risk prevention. To establish a unique corporate culture, CPA firms could start from the following aspects. First, the firms need sum up the fine culture tradition, refine the core values, and determine the objectives and contents of the cultural construction, to form the firms' cultural norms, to make it an important part of the employee code of conduct. Second, when building firm culture, the firm partners should play a leading model-role, influence the entire team with their outstanding character and diligent work style and create a positive cultural environment jointly. Third, The firm culture construction should be integrated into the whole process of practising, be combined with development strategy, and enhance their sense of responsibility and mission, so that employees' own value could be fully reflected in the development of the accounting firms.

5 Conclusion

After 30 years of hard work, talent constructions of the CPA profession have made considerable progress. Guided by "the Guidance on Strengthening Personnel Training of CPAs", with a standard of "Guideline on the Competency of CPAs", and based on the "Policy of Continuing Education System of Chinese Certified Public Accountants", the industry builds its professional training system. CPA firms which are the basic units of the team, should attach importance to the building of HR development strategy, establish HR development goals, combining with the forecast on both present and future demand, develop the overall HR plan and framework system, optimize human resources overall layout, make clear the requirements for development, and management, in order to enhance the firms' core competitiveness.

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The Emergence of Strategic Human Capital Under the Differentiation Strategy: Data from Manufacturing Industry

Su-ying Gao, Long Xu, Yan-li Zhang, and Hong-feng Zhang

Abstract The emergence of strategic human capital is to aggregate, amplify, and change qualitative individual KSAOs by implement internal HR practices which have the coordinative attributes. A mass of data were collected from self-administered questionnaires answered by HR managers from 152 manufacturing firms within Beijing–Tianjin–Hebei regions. We divide the individual KSAOs into two aspects: cognitive KSAOs and noncognitive KSAOs. Strategic human capital is measured by its characteristics of value, rareness, imitability and organization (VRIO). The results of this research show that cognitive KSAOs has a positive impact on strategic human capital, and it completely mediates between strategic human capital and noncognitive KSAOs. Based on above research, we introduce internal HR practices as an independent variable to analysis the relationship between cognitive KSAOs and noncognitive KSAOs. The consequence shows that both of the KSAOs have a significant impact on the emergence of strategic human capital.

Keywords Internal HR practices • KSAOs • Resource-based view of firms (RBV) • Strategic human capital

1 Introduction

With the arrival of the era of globalization, manufacturing enterprises have to deal with not only local rival but also the global market. Nowadays, facing the highly competitive situation, the relationship between traditional resources (such as labor, capital) and sustained competitive advantage is becoming weaker and weaker. Because of its VRIO characters, the importance of human capital is widely

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accepted by researchers and scholar (Barney 2001). As a special resource within the boundaries of enterprise economic area, strategy human capital is closely related to decision-making and strategy implementation. As a matter of fact, we should have a profound understanding of strategic human capital.

Recently, there is a wave of researches focusing on the relationship between HR practice and sustainable competitive advantage. However, this stream of research almost seems to be unnecessary. For this reason, Wright and McMahan (2011) advocated scholars focus on human capital itself. So, this paper draws on the framework of RBV, selecting manufacturing enterprises which implement differentiation strategy to study the strategic human capital emergence mechanism.

2 Methodology

The concept of human capital has been existed for a long time. It originally appeared in the economic literature. Becker defined human capital as the individuals' knowledge, information, ideas, skills and health. However, different scholars have various opinions on human capital. In general, human capital is defined as the sum of the knowledge, experience and skills of internal members of organization. However, as an organization resource, human capital belongs to the employees rather than the companies. The results in companies can't effectively take advantage of those resources to obtain sustained competitive advantage. This situation makes human capital static and inert (Gao Su-ying et al. 2012), and that resource don't have VRIO characteristics. Only when human capital and corporate strategy is matched, VRIO can be embodied. For those reasons, we defined strategic human capital which originated from the internal staff of organization as an organizational resource. Individual knowledge, skills, abilities, and other characters (KSAOs) was accumulated, amplified and qualitatively changed by HR practices. Then human capital becomes strategic property, which means that human capital can be leveraged to achieve sustainable competitive advantage (Barney and Hesterly 2008), so we call it strategic human capital.

Recently, researchers believe that employee play an important role in the relationship between strategic human capital and competitive advantage (Filin and Hesterly 2007; Lepak et al. 2007; Gerhart 2005). Abell and Felin pointed out that we should focus on the individual behavior as well as each other's interaction. Wright also emphasizes the importance of employee's personal knowledge, skill, ability and other characters. At the individual level, he said, human capital can yield positive outcomes for employee, and it can be combined in a way that creates value for the unit level. Moreover, how to measure human capital? Most scholars use individual human capital instead of strategic human capital. In Carmeli and Schaubroeck's (2005) research, they measure the level of education, training, work experience and skills of the entire company to estimate human capital. Takeuchi, Lepak, Wang and Takeuchi (2007) attempted to take multiple raters to assess organizational human capital in order to minimize the common method error. Hitt et al. (2006) also have measured human capital in law firms using proxy measures such as ‘quality of law school attended by partners’, ‘experience as partners in the current law firm’. It shows that scholars who work in the HR literature tend to use individual KSA as an alternative to strategic human capital. Compared to the strategic human capital, individual KSAOs are more easily to be measured. Despite of this, we cannot ignore the isomorphism between individual KSAOs and strategic human capital. The isomorphism means that individual KSAOs and strategic human capital have similar external morphology but different internal essential. In this view, we argue that strategic human capital as the dynamic capabilities of the organization, its source is individual KSAOs.

Psychologists, on the other hand, classified individual KSAOs into cognitive and noncognitive KSAOs. Cognitive KSAOs refers to something that a person can do, and noncognitive KSAOs refer to something that a person will do. Among the previous studies, most scholars use employees’ cognitive KSA instead of strategic human capital. Therefore, it is no doubt that cognitive KSAOs is a source of strategic human capital. But, what are noncognitive KSAOs? Researchers defined it as employees’ personality, value and interests. Luthans (2005) named it as psychological capital, and believed that that resource could help company to keep the sustainable competitive advantage. In the field of strategic human resource management, Bandura argue that when staff are facing greater pressure, their tension is a balk to handle their job, and then lead to lower job performance. Ployhart and Moliterno (2011) figure out noncognitive KSAOs is expected to influence how quickly and how much the employees’ learned. In other word, those who have greater noncognitive will learn faster and more effectively, so they can develop great cognitive KSAOs.

Wright et al. (2001) believe that HR practice can influence the accumulation of employees’ knowledge, skills, abilities and others characters. Ferris et al. consider that HR practices can nurture employees’ organizational honor, make them identify with organizational culture and target and more initiative to take participate in organizational work and then could improve their job performance. Similarly, Jiang Jian-wu and Zhao Shu-ming (2007) believe that company can make its own staff capacity more in line with strategic demand through HR practices. Meanwhile, Gao Su-ying, Zhao Shu-ming and Zhang Yan-li consider that HR practices partially mediate the relationship between strategic human capital and corporate competitive advantage. Thus, we believe that HR practices can adjust, integrate individual KSAOs to enable employees obtain cognitive KSAOs which are needed, and to make employees willing to take action to the realization of the strategic goals. In sum, HR practices make individual KSAOs could become the strategic human capital through HR practices.

Draw on resource-based view, researchers suggest that organization should implement HR practices according to their own strategic goals. Shererd and Kyungmook (2002) suggest that U.S. law firm should take a way called ‘dual career path’ to solve the lack of human capital. Lepak and Snell combined transaction cost economics; human capital management and RBV to evolve four different HR practices systems to deal with the different strategy. Therefore, we believe that cor-

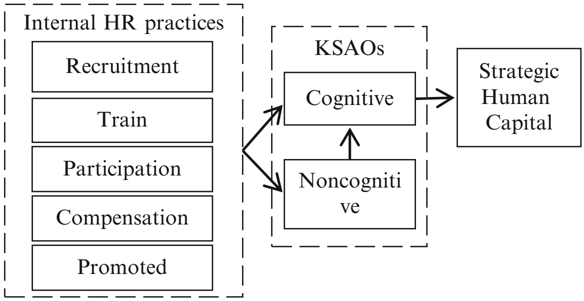

Fig. 1 Concept model

poration which implements differentiation strategy more like encourage innovation, adopt high decision-making authority and other HR practices which can make its own strategic human capital increase. So we named it as internal HR practices which utilize this kind of HR practices. Executing internal HR practices, corporations tend to carried on more internal training and internal promotion. In the recruitment process, compared to cognitive KSAOs, corporations pay more attention to applicant's noncognitive KSAOs. Meanwhile, corporations always highlight authorization mode, motivate the team performance and implement profit sharing mechanism.

Based on the above literature review, we made the following hypothesis:

Hypothesis 1: Cognitive KSAOs is positively related to developmental strategic human capital.

Hypothesis 2: Noncognitive KSAOs is positively related to developmental cognitive KSAOs.

Hypothesis 3: Cognitive KSAOs is mediating variable between noncognitive KSAOs and strategic KSAOs.

Hypothesis 4: Internal HR practices have positive affection to the relationship between cognitive KSAOs and noncognitive KSAOs.

The concept model is shown in Fig. 1.

3 Results

3.1 Research Design and Sample

The data were gathered through questionnaires. Likert five-dimensional scaling method was selected to estimate human capital and HR practices (Table 1).

In addition, primary data on the four variables, cognitive KSAOs, noncognitive KSAOs, strategic human capital and Internal HR practices, were obtained with the help of a structured questionnaire that was mailed to manufacturing facilities' human resource department managers located in Beijing-Tianjin-Hebei region by Email and Internet website. The participants were asked to fill out the questionnaire honestly. 218 surveys were returned, but only 152 were useable.

Table 1 Model variables

Latent variable	Connotation
Cognitive KSAOs (C-KSAOs)	Cognitive KSAOs is measured through three aspects: knowledge, skill, abilities
Noncognitive KSAOs (N-KSAOs)	Noncognitive human capital is measured by employees' agreeableness, conscientiousness, and situational judgment
Strategic human capital (SHC)	We measure strategic human capital through its VRIO characters
Internal HR Practices	HR practices are measured thought five accepts: recruiting, training, employee involvement, compensation and promoted

Table 2 Cronbach α coefficient

Variables	Cronbach's α coefficient	Combination α coefficient	
C-KSAOs	0.840	0.931	
N-KSAOs	0.881		
SHC	0.889		
Internal HR practices	Recruitment	0.778	
	Train	0.9	
	Participation	0.852	0.944
	Compensation	0.689	
	Promoted	0.879	

3.2 Reliability and Validity Analysis

In this paper, SPSS 19.0 is used to test 152 valid questionnaires. Table 2 shows the Cronbach α coefficient. Table 3 shows the KMO and Bartlett analysis result. Evaluation of each variable and the overall questionnaire Cronbach α coefficients were above all 0.7, indicating that the scale has good reliability.

This article scales were derived from early studies in this field, and we have done a little correction based on Chinese specific situation. Before a wide range of questionnaires, we also had taken a small-scale trial and had a little bit modification on the questionnaire basic on the feedback. Therefore, the questionnaire has good reliability. And, we adopted construct reliability indicators and average variance extracted (AVE) to analysis constructs validity. The result is shown in Table 4. Each latent variables construct reliability greater than 0.9, much higher than the standard value of 0.6. And all variables' AVE were greater than 0.6, also higher than the standard value of 0.5.

Table 3 KMO and Bartlett's analysis

			Bartlett's		
Variables	Kaiser-Meyer-Olkin		df		Sig.
C-KSAOs	0.837	0.903	15	171	0.000
N-KSAOs	0.842		10		
SHC	0.842		10		
Internal HR practices	0.927		136		0.000

Table 4 Construct validity result

Latent variables	Validity of construct	Average variance extracted
C-KSAOs	0.931	0.674
N-KSAOs	0.924	0.639
SHC	0.943	0.771
Internal HR practices	0.944	0.774

3.3 Empirical Analysis

In this paper, the hierarchical regression is used to test each hypothesis.

Firstly, Building cognitive KSAOs and strategic human capital structural equation modeling, testing whether cognitive KSAOs is associated with strategic human capital,

$$SHC = \alpha + \beta C\text{-}KSAOs + \zeta \quad (1)$$

Secondly, Building cognitive KSAOs and noncognitive KSAOs structural equation modeling, testing whether noncognitive KSAOs is associated with cognitive KSAOs,

$$C\text{-}KSAOs = \alpha + \beta N\text{-}KSAOs + \zeta \quad (2)$$

Thirdly, Building strategic human capital, cognitive KSAOs and noncognitive KSAOs structural equation modeling, testing whether cognitive KSAOs is a mediating variable between noncogntive KSAOs and strategic human capital,

$$SHC = \alpha + \beta_1 C\text{-}KSAOs + \beta_2 N\text{-}KSAOs + \zeta \quad (3)$$

Finally, building internal HR practice, strategic human capital, cognitive KSAOs and noncognitive KSAOs structural model equation, testing whether internal HR practices is moderating variable between cognitive and noncognitive KSAOs.

According to Fig. 2: Cognitive KSAOs is positively related to the development of strategic human capital ($\beta = 0.65$, $p < 0.001$), Hypothesis 1 is verified. Strategic human capital is cognitive KSAOs which meet the requirements of corporate strategy, aiming at achieving its own strategic goals. Individual Knowledge, skill and

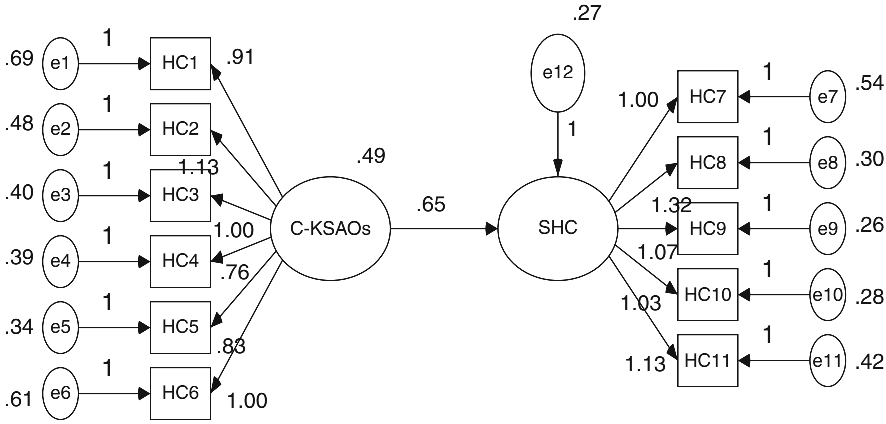

Fig. 2 Model 1

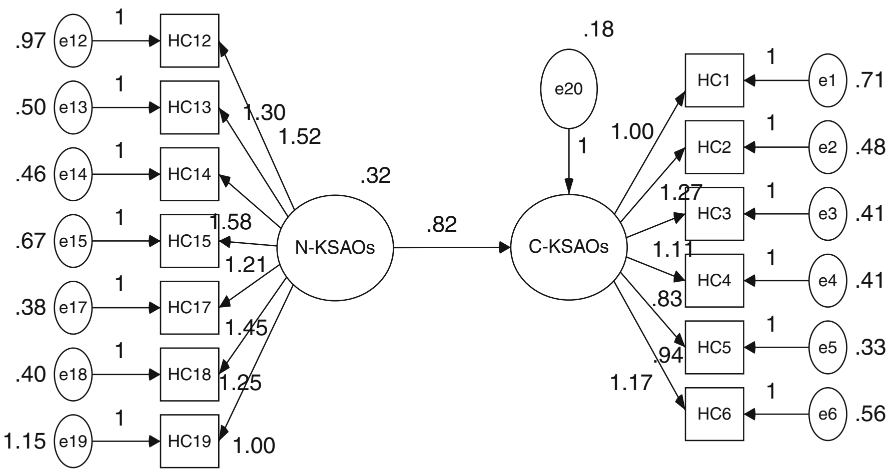

Fig. 3 Model 2

abilities can help corporations to obtain sustained competitive advantage. Therefore, enhancing cognitive KSAOs will help the positive development of strategic human capital.

According to Fig. 3, we have analyzed the relationship between noncognitive and cognitive KSAOs. The analysis results show that noncognitive KSAOs is positively related to the development of cognitive KSAOs ($\beta = 0.83$, $p < 0.001$). Hypothesis 2 is verified, too. In this paper, we defined noncognitive KSAOs as employees' willingness or appetence. Improvement of noncognitive KSAOs, it means that employees are pleased to enrich their own knowledge, skills, and abilities. Thereby, noncoginitive KSAOs will help the positive development of cognitive KSAOs.

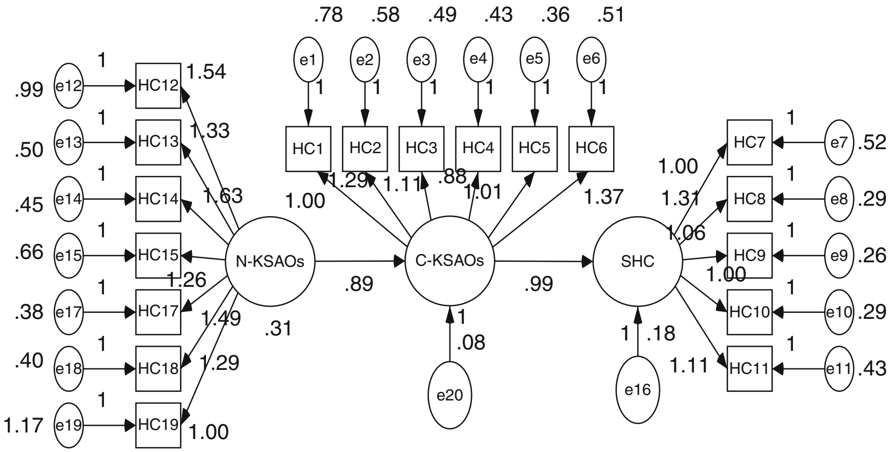

Fig. 4 Model 3

According to Fig. 4: The relationship between cognitive KSAOs and strategic human capital has changed from ($\beta = 0.65$, $p < 0.001$) to ($\beta = 0.99$, $p < 0.001$), but the relationship between cognitive KSAOs and noncognitive KSAOs has only changed from ($\beta = 0.83$, $p < 0.001$) to ($\beta = 0.89$, $p < 0.001$). Apparently, the relationship between cognitive KSAOs and strategic human capital is enhanced, and the relationship between noncognitive and cognitive KSAOs is abated. Hypothesis 3 is also verified. Noncognitive KSAOs can effectively enhance the stock of strategic human capital through cognitive KSAOs. For this reason, cognitive KSAOs are a mediating variable between noncognitive KSAOs and strategic human capital.

Adding moderating variable ‘HR practices’ to the structural equation model, the analysis results are shown in Fig. 5. The latent variable ‘HR practices’ involves five observed variables: recruitment (ZP), train (PX), Participation (CY), compensation (XC) and promoted (JS). The path coefficient parameters are 0.79, 0.99, 1.02, 1.04, and 1. The path coefficient parameter on Training, participation, compensation and promoted were significantly higher than recruitment. The corporation implements HR practices by taking action in large number of on-job-time training, high authorization mode and other practices, we named it as internal HR practices. Internal HR practices, as a moderating variable, makes the cognitive KSAOs closely relate to strategic human capital ($\beta = 1.02$, $p < 0.001$), but the effeteness of noncognitive KSAOs is decreased to ($\beta = 0.72$, $p < 0.001$). Therefore, through internal HR practice, cognitive KSAOs can be more effectively emerged into strategic human capital, and make it meet the demand to corporate strategy. Meanwhile, HR practice can affect the cognitive KSAOs and noncognitive KSAOs. Their coefficients are ($\beta = 0.14$, $p < 0.001$) and ($\beta = 0.58$, $p < 0.001$). There is a huge difference between them. The affection between Internal HR practices and noncognitive KSAOs is significant. The corporation can regulate employees’ willingness to enable them to integrate into the corporate culture better, to mobilize the enthusiasm of the staff, to

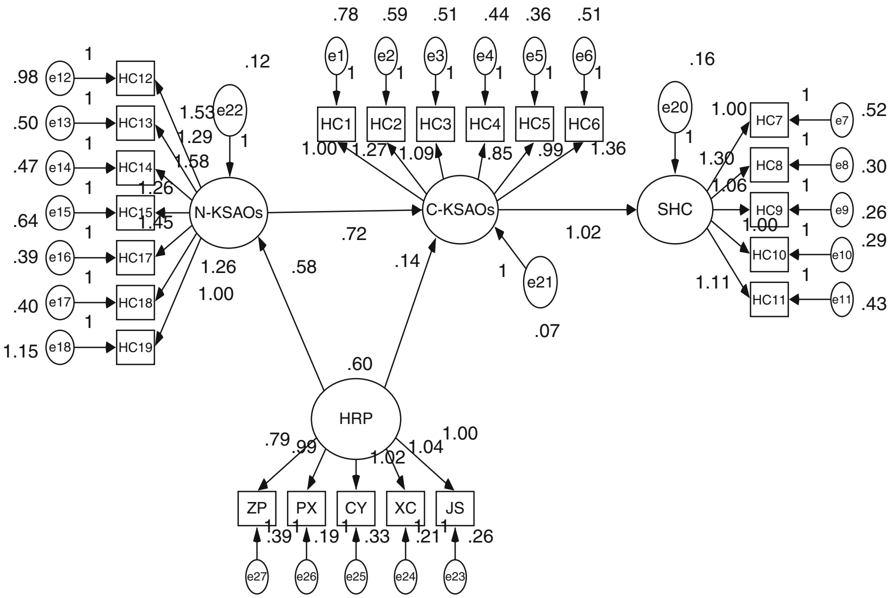

Fig. 5 Model 4

spontaneous service for corporate strategy by enterprise authorization mechanisms, as well as various types of performance appraisal, career advancement, etc. Finally, we verified Hypothesis 4.

4 Conclusion

In the manufacturing enterprises, the source of strategic human capital is employees' cognitive KSAOs, which includes individual knowledge, skills, and abilities. However, it does not mean that all of the cognitive KSAOs can be transferred to strategic human capital. When cognitive KSAOs is needed by organization's strategic goals, it can be transferred and emerged into strategic human capital. How to make static and inert cognitive KSAOs become more effective and dynamic is a key issue in this paper. Therefore, we have analyzed the relationship between noncognitive KSAOs and cognitive KSAOs, and then we regard cognitive KSAOs as a moderating variable between cognitive KSAOs and strategic human capital. To enhance the noncognitive KSAOs that could make employees take the initiative seek the acquisition of various opportunities to obtain various cognitive KSAOs which are suitable for corporate strategy. Internal HR practices can adjust cognitive and transform them into strategic human capital. The process of selecting can select one who has appropriate cognitive and noncognitive KSAOs; the process of providing can provide new recruits with on-the-job training that can make them match up with strategy; encourage employees to participate in the decision-making and implementation process, and make the workflow and work experiences of their corporations become well known to them. It can also make employees willing to contribute to strategic goals; paying generous compensation and providing preferment for some staff who contribute to the achievement of strategic goals, internal HR practices can enhance employees' both cognitive and noncognitive KSAOs, and turn them to strategic human capital.

Base on RBV, this paper discusses the emergence of strategic human capital in manufacturing enterprises which have adopted the differentiation strategy. Firstly, we divide individual KSAOs into two aspects: cognitive KSAOs and noncognitive KSAOs. Cognitive KSAOs is referred to something that the employee can do, including knowledge, training experience, and health. Noncognitive KSAOs is referred to something that the employee is willing to do, including their personality, value and conscientiousness. Secondly, we defined the concept of strategic human capital as a type of organization dynamic resource; it can derive from cognitive KSAOs; as noncognitive KSAOs have effect on strategic human capital through cognitive KSAOs. Both the cognitive and noncognitive KSAOs are accumulated, amplified and changed qualitatively through internal HR practices. In this paper, we purpose four hypotheses, and test them one by one. The results gave us a comprehensive understanding of strategic human capital emergence mechanism clearly.

Although all hypotheses are verified, there are still some issues to be solved. In the pre-research phase, we conduct a rigorous set of questionnaires and rigorous analysis of the reliability and validity to mitigate common method bias, but error still exists. Because this method is based on the perceptions of a single respondent, rater bias and inaccuracy of reporting is present. In the future, we should think more accurately about the question that we seek to answer regarding human capital and let that drive our choice of measurement strategy. Furthermore, we choose the manufacturing industry as the selection criteria of the sample, and ignore corporate survival year, size, and other relevant factors. In the future research, we could consider those factors as control variables added into model.

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Competency-Based Public Servants Training Needs Analysis

Li-ping Fu, Yue-feng Luo, and Xiao-ming Zhou

Abstract Training Needs Analysis is not only the prerequisite to set training goals and plans, but also the basis of measuring training results. In reference of "personal-task-organization" analysis idea in classical Training Needs Analysis Models, Competency Theory has been applied to Training Needs Analysis of public servants so as to build comprehensive analysis mode. This comprehensive analysis model based on competency complies with the local government policy as well as fits more easily in with government organization development, because it serves as a brand-new scientific model beyond the limitation to performance gap.

Keywords Competency • Public servants • Training needs analysis

1 Introduction

More and more government organizations have gradually regarded the training as one kind of valuable investment behavior so as to manage and develop human resources of public sectors. Obviously, the training activity has become an indispensable part of the modern government operation. However, the traditional public servants training focuses mainly on the change of knowledge, skills and personal quality, which is difficult for the training executor to evaluate. Even though the change does exist, no concrete theory can prove that kind of change will directly

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enhance the performance. After all, the overall performance of public servant is what the government and society care more about. Thus, Competency theory is suggested to analyze the relation between public servants competency and government performance (Jianfeng 2003).

2 Competency and the Connotation of Competence Model

In 1973, David C. McClleand officially came up with the conception of Competency (David 1973). In 1995, hundreds of human resources specialists defined it as to be "a combination of knowledge, skills and behavior used to influence one's main work; it is closely linked with performance; some generally accepted standards can evaluate it and in turn it will be improved by training and development". The most popular concept, however, was introduced by Spencer in 1993: "Competency is the underlying characteristics of an individual, which is able to consistently distinguish outstanding performer from the common in a given job, organization or culture" (Spencer and Spencer 1993).

The main method to identify competency is to construct corresponding Competence model which refers to the introduction to the behavior of achieving success in a given job. In 1998, Williams held that "Competence model is combined by excellent performances of a given job, so it involves many competency structures. And it presents the unique combination of skills, knowledge and feature required to efficiently complete a given task" (Williams 1998). Generally speaking, three standards must be met to build an effective Competence model: the selection of special competency to obtain good performance; center on organization strategy; meet the needs of organization future development (Yanbei and Jianchun 2007).

3 The Characteristics of Competency-Based Public Servants Training Needs Analysis

Competency-based training needs analysis establishes job training needs according to governmental organization environment, organization variables and the essential characteristics of excellent public servants. This kind of analysis is a strategy oriented analysis method through which the training contents and process, on the one hand, will meet the requirements for public servant position, and on the other hand will meet the needs of government development. Besides, the training needs analysis based on competency more and more tends to be future oriented, for the position requirements for people are made in accordance to the government future development. Compared to the traditional training needs analysis, the present training needs analysis is equipped with several features as listed below:

3.1 Paradigm Shift

The previous public servant training analyzed mainly on performance differences or "performance gap" from which the knowledge and skills weakness will be revealed further to establish the training needs. Now, Competency theory has been brought in. Though the public servant training system based on competency also begins from performance analysis, in most cases it concentrates on the difference or gap of competency (Peilin 2011). In order to diminish or eliminate the gap or differences, the public servant training system based on competency pays much attention to the differences of explicit knowledge, skills, implicit competence or characteristic as well as the gaps of relevant competency, so that the public servant through training can meet the government present demands or future development needs.

3.2 Highly Related to the Core Competency of Government

The competency-based public servants training system needs to be designed in combination with the competency of government because individual competency is the basic component or unit of organizational competency. The individual competency decides the job performance of individual public servant, and the level of government competency determines whether government can obtain or maintain the competitive advantages and keep promoting the performance in order to achieve the strategic goal. A remarkable design of competency-based training system should be able to analyze the whole collective learning and performance capability of an organization, namely, the organizational competency analysis. The organizational competency analysis can be divided into the analysis of core technical competency and the analysis of core operational ability (Allee 1997). What need to be mentioned is that the core technical competency includes the knowledge and skills of each member, physical technology system, management system and the criteria of value, which, in regard to the competency-based training system, are highly related to that of public servants' knowledge and skills, management system and value system.

3.3 Connected to the Performance Standard

The traditional analysis pattern of training needs was established by McGehee and Thayer (1961) which consists of organizational analysis, assignment analysis and personnel analysis. The organizational analysis indicates what need to be trained (the purpose); the assignment analysis decides what should be the main content of training; the personnel analysis determines who should be trained and what kind of training they need. The traditional training needs analysis excessively depends on investigation rather than establishing a connection between training itself and organizational output and, it ignores the importance of standardized work environment and relevant penalties and fails to specify the correlation amongst organization, assignment and personnel when the evaluation and analysis of performance discrepancy are ongoing. The competency-based public servants training system, on the one hand, has already taken the performance discrepancy of public servant into consideration when the public servant competence model is being constructed; on the other hand, the training needs analysis also operates in accordance with the performance discrepancy analysis. Therefore, the evaluation of performance can be used to determine performance discrepancy in order to find the competency shortage and then, come up with the training requirement, that's how an unified analytical concept is formed amongst the three elements of training needs analysis. What's more, it considers the potential needs of organization and job position when the performance target is set and pays more attention on analyzing the relationship between public servants performance and target performance, hence the public servants training and whole output and improvement of government performance are linked.

4 The Methodology of Public Servants Training Needs Analysis Based on Competence Model

Based on the characteristics and definition of training needs analysis, combined with competency theory, the public servant training needs analysis based on competence model can be conducted through following procedures.

4.1 Using Organizational Analysis to Determine the Core Competency of Government

Organizational training needs should take the core technical ability as well as core operational ability into consideration. A logo can be formed through such abilities which can be used to identify the organization and represents the ability of collective learning and performance. Besides, while analyzing the core competency of government, the needs should be connected with the development strategy, target and organizational cultures in order to make the pre-established competence model fit specific environment. It is necessary to conduct analysis on the governmental environment and organizational variables such as current development status, difficulties, development strategy, organizational characteristics etc. Hence the development of government and possibilities of changing work task can be predicted; the job requirement in regard to the future development of government as well as core competency can be precisely inferred. Proper personnel who might be essential to the government can be found through the analysis result generated from above.

4.2 Using Assignment Analysis to Establish the Public Servants Competence Model

The key of conducting competency-based assignment analysis lies on the construction of public servants competence model of each important position, which requires five specific steps (Bing and Xiaofei 2004):

1. Determining the performance standard. The performance standard should be based on the foundation of clear strategic target of government firstly. Furthermore, the identification of ideal standard of excellent public servant and normal public servant can be based on the phase assessments and annual assessments in line with the opinions of group of experts.
2. Choosing performance standardized sample. Choosing a group of excellent samples and a group of ordinary samples respectively based on whether they meet the requirement of performance standard.
3. Obtaining data from the samples. Behavioral event interview is a method which investigates the past and tends to be more open. The sample which contains detailed past information can be obtained by combining the method of Behavioral event interview and questionnaire while the public servants competence model is under construction.
4. Analyzing the data resources and establishing Competence model. By analyzing the current data, the elements indicators' occurrence frequency and relevant statistical indicators of the superior group and the standard group can be compared. Then we need to find out the characteristics of their similarities and differences. To classify the characteristics according to different subjects, and to estimate the general weight of each feature group based on the concentrating degree of the frequencies. At last, we can identify the Competency for differentiating the superior and the standard, the Competence model is formed.
5. Verifying the Competence Model. There are three methods for verifying the Competence Model for public servants. Tang (2001): the first method is to select the second criterion sample, to collect the data again through behavior interview method and to analyze whether the established public servant Competence model can distinguish the superior and standard of the second criterion sample, which means verifying the 'cross validity'. Secondly, according to the Competence model evaluation tool, to evaluate the core competency of the above Competence model for the second criterion sample. We can then investigate whether the assessment result of the superior and the standard differ largely, which is to verify the 'construct validity'. Thirdly, to select by behavior event interview or other tests, or to use the public servant Competence model for training and do researches with follow-ups. And then, to investigate whether the public servants' working performances are improved after the training, which is to verify the 'predictive validity'.

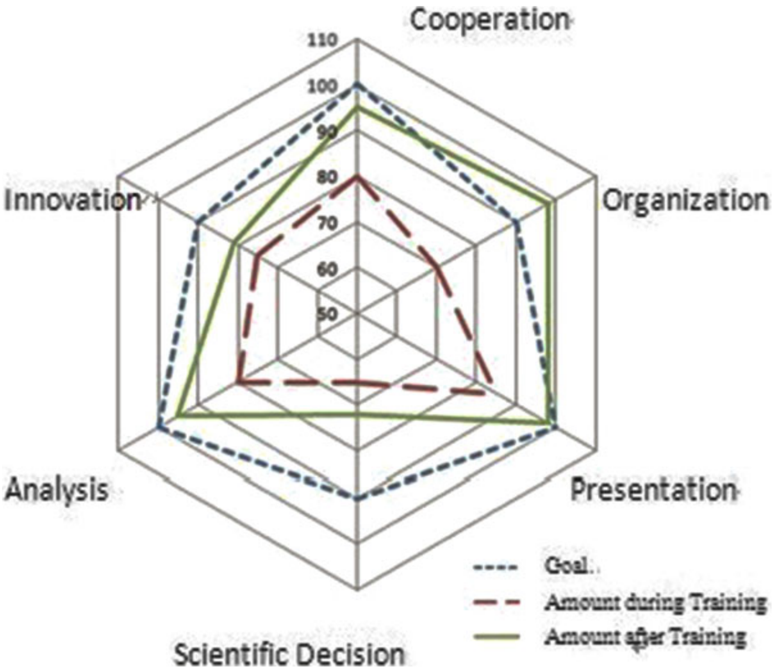

Fig. 1 Radar chart of differences between the competency evaluation and the competence model for a public servant of county in a new district

4.3 Human Analysis, to Propose Public Servants Training Needs

The key of this step is to analyze the disparity between the public servants' current situation and ideal situation. Its general process is as follows:

1. Seeking the disparity. After the Competence model is built, we can analyze the public servants' reality situation to find out the differences. The analysis includes two aspects: The public servants' current competency and performances, which are Competency assessment and performance feedbacks. The former is built on the basis of the Competence Model, which is to estimate the gaps of their competency on each item; the latter is to propose aspects for improving according to the public servants' performance tests results (Kai and Man 2009). During the operating process, the competence assessment can be usually evaluated 360° comprehensively. The radar chart can show the value gap between the Competence Model and the collected data from the Competency evaluation. For reference, this research will demonstrate a radar chart to show the difference between the Competency evaluation and the Competence Model for a public servant of county in a new district. As Fig. 1 showed:

2. Analyzing the causes of the disparities. After we identify the competency disparities, we also need to analyze the causes. Not all competency gaps can be eliminated by training. Some competency differences are caused by environment, culture and incentive systems. Some are caused by the public servants' insurmountable personalities. This need be solved by specifying the target and taking actions purposefully.
3. Determining the training needs. After the analysis of causes for Competency disparities, we can identify whether to adopt training methods to decrease the disparities. Then we need to determine the main content for the public servants' training needs. Meantime, the department in charge of training needs to classify and generalize their training needs, which means to identify the similarities and individualities, short-term and long-term needs and so on. Besides, the government can also analyze and evaluate the training cost in this way.

5 Conclusion and Discussion

The analysis of the public servants' training needs based on the Competence model has positively affected both on public servants' career development and organizations development. It can improve the consistency of strategic targets between the training needs for public servants and the government development. It can also avoid the negatives caused by the aimless training. Competence Model is a new way of thinking for human resource administration and public servants training and the key step to enable the human capital to become competitive strengths for public departments.

However, it is worthy to mention that the Competence Model is a comparably new method and administrative tool in our country at this moment. It is especially rarely adopted in government departments. There are still a number of issues to be discussed during the practical use. Its applicability and operability still need to be tested via practice. Its administrative value can only be achieved if the Competence Model is continuously modified, adjusted, improved and applied effectively according to the reality.

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Part IX
Management Sciences – Management Information System and Simulation

An Exploration of Data Quality Management Based on Allocation Efficiency Model

Hao Jiang, Jia-xin Liu, Yi Zhang, and Chun-hua Yu

Abstract The quality of data is often defined as "fitness for use", the ability of data collection to meet users' requirements. The assessment of data quality dimensions should consider the degree to which data satisfy users' needs. User expectations are clearly related to the selected information and at the same time the information can have different utilities depending on the type of users that accesses it. In this thesis, the information is considered as a product of a specific service and data quality as a component of the service quality. For each service, it is possible to identify a provider and a final user. In the data quality literature, authors have always only considered as important the final users' perspective declaring that providers should adapt their service offerings in order to completely satisfy users' requirements. This paper presents a utility-based model of the provider and customers' interests developed on the basis of multi-class offerings. The model is exploited to analyze the optimal service offerings that allow the efficient allocation of quality improvements in activities for the provider.

Keywords Allocation efficiency model • Data quality costs • Data quality function • Data quality management

1 Introduction

Data is a valuable resource has grown increasingly prevalent among business and IT executives, and is reflected in increased spending on data management activities. However, are organizations really taking action and applying a suitable data management model to manage their data and information? In order to help

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organizations deal with difficulties of data quality, this thesis will present a model on data quality management. Data is used for all aspects of business-sales, marketing, production, support, finance and legal and so on. Organizations that harness accurate data to improve efficiency and effectiveness have a massive advantage over their competition. Improved data quality can add a lot of value to the company, either through optimization in operational systems or by improving the value of knowledge generated through a business intelligence process to improve the decision making process. Therefore, applying a suitable data quality methodology is extremely important for an organization to run a business. However, organizations always only considered as important the final users' perspective declaring that providers should adapt their service offerings in order to completely satisfy users' requirements. Difference with other data quality methodologies, the thesis presents a utility-based data quality model. The model is exploited to analyze the optimal service offerings that allow the efficient allocation of data quality improvements activities for the provider, considering both the users and the providers' perspectives and providing a support in the definition of optimal service offerings for data services that maximize their gains.

2 Literature Review

The quality of data is often defined as "fitness for use", the ability of data collection to meet user requirements (Orr 1998; Wang 1998). Data quality is a multi-dimensional concept that evaluates the suitability of data for the tasks in which they are involved, and thus for the users that access them.

Data quality literature has always focused its attention on the definition of methodologies and methods that support providers in the achievements of data quality targets that would completely meet users' needs. Quality management mainly suggests the adoption of the zero defects approach that consists in setting targets to the highest quality values (English 1999). One of the major foundations of a zero defects program is the five S (seiri, Seiton, Seiso, Seiketsu, Shitsuke), which has been used in Japan for sometime and recently introduced to the American Semiconductor industry. It was coined by Philip Crosby in his 1979 book titled, *Quality Is Free*. His position was that where there are zero defects, there are no costs associated with issues of poor quality; and hence, quality becomes free. Zero defects concept is a way of thinking and doing that reinforces the notion that defects are not acceptable and everyone should "do things right the first time". The idea is that with a philosophy of zero defects, you can increase profits both by eliminating the cost of failure and increasing revenues through increased customer satisfaction. Zero defects approach is referred to as a philosophy, a mentality or a movement (Evans and Lindsay 2005). It's not a program, nor does it have distinct steps to follow our rules to abide by. This is perhaps why zero defects can be so effective, because it means it's adaptable to any situation, business, profession or industry.

The question that often comes up when zero defects is discussed, is whether or not zero defects is ever achieved. Essentially, does adopt a zero defects environment only set users up for failure? If the organization follows the zero defects approach in areas which do not need it, resources may be wasted. Furthermore, reaching the highest quality values might lead to quality improvement that the organization may not be able to afford. Hence, this approach is sometimes excessive, since it often involves high quality improvement costs for the service providers. It would be better to adopt an approach that fixes data quality targets on the basis of the requirements of users that access data and of the providers' advantage (Cappidlo and Ficiarop 2006).

The notion of data quality has been widely investigated in the literature. It refers to the degree to which data satisfy user requirements or is suitable for a specific process. Both theoretical and experimental results indicate that data quality is a multi-dimensional concept (Redman 1996; Wand and Wang 1996; Wang and Strong 1996). The data quality literature provides a thorough classification of data quality dimensions, even if there are discrepancies in the definition of most dimensions due to the contextual nature of quality (Jarke et al. 1999; Naumann 2002). By analyzing these classifications, it is possible to define a basic set of data quality dimensions including accuracy, completeness, consistency, timeliness, interpretability and, accessibility, which represent the dimensions considered by the majority of the authors (Scannapieco and Catarci 2002).

In a word, to achieve the benefits and ensure data quality, data must be produced in accordance with clearly defined data quality dimensions, just like other products (services and goods) are supplied and evaluated according to specific quality characteristics. Data quality dimensions will depend on the industry context and customer requirements. Company should start working from the structure of data resources, the place of data quality management system in the data manufacturing process, data assessment and processing to the final data product that satisfy or even exceed data user expectations and needs. Based on literature review, this paper will propose a data quality model which is utility-based data quality model.

3 Allocation Efficiency Model

In the context of mechanism design, such as, for instance, in optimal auction design (Klemperer 1999), there are two main approaches to evaluate the properties of a mechanism, i.e., utility maximization and allocation efficiency. The utility maximization perspective usually takes the point of view of one participant in the allocation problem, i.e., either the provider or customers, and it pursues the objective of maximizing the utility of such participant. In this thesis, we tackle the problem of service offerings for data services definition by referring to the other perspective of mechanism design, i.e., the perspective of allocation efficiency (Fig. 1). The objective, in this case, is to jointly consider the interests of data

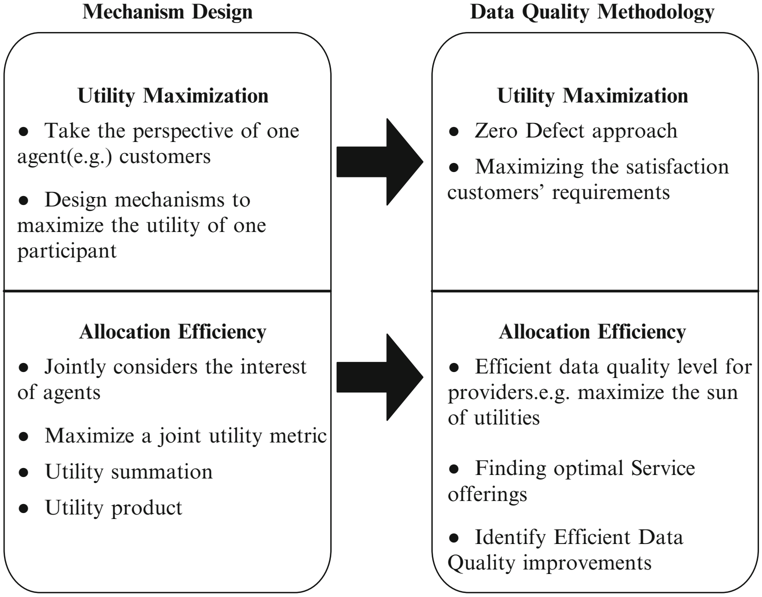

Fig. 1 The metaphor of mechanism design for data services contexts

providers and customers. Furthermore, sources of benefits and costs related to data service offerings for providers and customers have already been analyzed by a large body of academic literature (Wang 1998; Martin and Markus 2004; Batini et al. 2008).

The allocation efficiency perspective is suitable to regulate long-term relationships between providers and customers. In the remainder, we show a preliminary consideration on the application of the allocation efficiency perspective in the context of data services. Let us consider the allocation efficiency problem in the data service scenario in which we are to maximize the sum of utilities of the data provider and the customers. The sum $U_p + U_c$ of the two aggregate utility values can be evaluated as:

$$U_p + U_c = \alpha \bullet B_p(QC) + V_c(QC) - C_p(QC) \tag{1}$$

The function $U_p + U_c$ is a function of the data quality offering implemented by the provider. A quality improvement is likely to result in a monetary benefit $B_p(QC)$ for the provider. $V_c(QC)$ is the value generated from the data quality level QC for a single customer. The term $C_p(QC)$ represents the cost sustained by the provider to provide a service offering QC. The coefficient α is a Boolean value, where $\alpha = 0$ represents the case of isolated services, whereas $\alpha = 1$ is the case of interconnected services. Then, in order to identify the service offering QC^* that maximizes the sum of the provider and the customers' utilities, we need to evaluate the derivative of the function $U_p + U_c$, w.r.t. to QC and put it equal to 0:

$$\mathrm{d}\left(U_p + U_c\right)/\mathrm{d}QC = \alpha \bullet \mathrm{d}B_p/\mathrm{d}QC + \mathrm{d}V_c/\mathrm{d}QC - \mathrm{d}C_p/\mathrm{d}QC = 0 \quad (2)$$

Hence, the condition to be solved for finding the optimal service offerings QC^* is as follows:

$$\alpha \bullet \mathrm{d}B_p/\mathrm{d}QC = \mathrm{d}C_p/\mathrm{d}QC - \mathrm{d}V_c/\mathrm{d}QC \quad (3)$$

The aforementioned condition leads to some conclusions that extend the common assumptions for which providers should always adapt their service offerings to users' requirements.

We want to stress that the configuration that maximizes the summation of utility of the provider and customers is the one for which the marginal benefit for the provider derived from savings in the costs of non-quality equals the difference between the marginal sustained costs and the marginal value created for the customers. In other words, the effort of the data provider should be devoted to finding the quality improvement activities and the service offerings which achieve a perfect balance between the costs that must be sustained to perform the improvement and the value created for customers. This assumption can be clarified by considering the two extremes of isolated and interconnected data services. For isolated services ($\alpha = 0$), the maximization of the utility summation is achieved when there is a perfect balance between the marginal costs sustained by the provider to provide quality of data and the value created for customers, that is:

$$\mathrm{d}C_p/\mathrm{d}QC = \mathrm{d}V_c/\mathrm{d}QC \text{ (for isolated data services)} \quad (4)$$

At the same time, when the provider achieves certain benefits in its internal processes from the quality improvement ($\alpha = 1$), the optimal service offerings is such that the marginal costs sustained by the providers are, at least partially, balanced by the benefits introduced by the quality improvement on internal processes.

Note that the utility model introduced so far leads to some considerations that differ from the common perceptions on data quality implied by classical data quality approaches. According to our perspective, the objective of the data provider is not to satisfy exhaustively the data quality requests of their customers, but it is rather the evaluation of an optimal set of data quality offering QC^*. Our model should be used to identify a specific set of requirements expressed by customers that must be satisfied in order to achieve the maximization of the provider and customers' utility. Such requirements are the ones that, in order to be fulfilled, require a quality improvement effort which balances the marginal value created for customers, and, for the provider, the marginal costs sustained for the quality improvements and the benefits derived from savings in the non-quality costs.

4 Exploitation of Model

The thesis intends to develop and generate data quality function for the service provider in order to support and contribute to the proposed allocation efficiency model which is described in this paper. Many claims of the importance of data quality costs are general. Particularly, there is no validated statistic and economic theory of data quality costs currently that could be used as a basis for data quality cost analysis. Nevertheless, the concept of quality cost is not new. There are many approaches; however most of these are used in the context of manufacturing at present. For this reason, to build a data quality cost model, the thesis now reviews major quality cost approaches in the context of manufacturing. This provides the basis for linking the cost classification to current quality cost theory and consequently helps to develop a data quality cost function that used in the works.

Considering all data quality assuring costs and according to a different orientation, all costs can be classified into three classes as below.

Repair costs: These costs associated with data and information is used to repair action. They are low as minimum data quality requirement and rise to its maximum at maximum data quality level.

Detection costs: This is another type of costs belongs to data-oriented techniques. For these costs similar consideration as for repair costs can be assumed. However, it seems reasonable that at a relatively high data quality level, detection costs should be lower than repair costs arise since repair action involves more effort than detection.

Prevention cost: It is argued that preventing quality defects results in reducing repair and detection costs significantly. This is due to the assumption, which is the sooner a defect is detected or prevented. The more savings can be made during subsequent processes.

From above analysis and classification of data quality cost, the thesis proposes that the total cost of data quality can be expressed by summarizing prevention costs, detection costs and repair costs related to the highest required data quality level of user classes. Comparing with historical concept of quality cost, there are some differences. Historical quality cost also takes into account low data quality cost. However, data quality costs that thesis proposed considering low data quality cost as benefits parameter and benchmark. Therefore, the total cost of data quality should only include prevention, detection and repair costs for this thesis. Below equations demonstrate the data quality cost model of this thesis.

Historical quality cost model:

$$C_{total} = C_{improvement} + C_{low\text{-}quality} \tag{5}$$

Interpretation data quality cost model from historical quality cost model:

$$C_{total} = C_{prevention} + C_{detection} + C_{repair} + C_{low\text{-}quality} \tag{6}$$

Transfer $C_{low\text{-}quality}$ to left:

$$C_{total} - C_{low\text{-}quality} = C_{prevention} + C_{detection} + C_{repair} \tag{7}$$

The cost of low data quality can be treated as a benefit benchmark. Deducted cost of low quality equals to increase benefits from the cost of prevention, detection and repair actions (B_{p+d+r}). Therefore, Formula (7) can be interpreted as:

$$C_{total} + B_{p+d+r} = C_{prevention} + C_{detection} + C_{repair} \tag{8}$$

Therefore, the total cost of data quality only depends on the cost of data improvement activities, which can be classified as prevention activities, detection activities and repair activities.

From above analysis, total cost of data quality should depend on the cost of data improvement activities including prevention cost, detection cost and repair cost. However, those costs are tightly linked with the highest data quality level requested from certain user class. Clearly, the highest data quality level depends on the particular industry structure and user characteristics. Furthermore, managers need to understand that the costs associated with too high of an emphasis on data quality to try to attain perfection comes at a price that is not linear with the resulting actual increase in data quality. Optimally, owners should strive to both consider the benefits of improving data quality (avoidance from costs of low data quality) and all the costs involved with those data quality improvement.

The thesis makes some assumptions on prevention cost function, detection cost function and repair cost function. The thesis assumes the function of data prevention cost is linear and it is expressed as:

$$\mathrm{C}_p = \alpha_p + b_p \bullet qc_K \tag{9}$$

(Where α_p is interception, b_p is slope and should be very small, qc_K is highest data level required from users.)

The function of data detection cost is exponential and this expressed as:

$$C_d = \alpha_D + b_D \bullet e^{qcK} \tag{10}$$

(Where α_D is a constant term, b_D is multiplying coefficient, qc_K is highest data level required from users.)

The function of data repair cost would be expressed as:

$$\mathrm{C}_r = \alpha_R + b_R \bullet e^{qcK} \tag{11}$$

(Where α_R is a constant term, b_R is multiplying coefficient, qc_K is highest data level required from users.)

The function of total data cost for service provider can be expressed as:

$$
\begin{aligned}
C(QC) &= C\ (qc_K) = C_p + C_d + C_r \\
&= \left[\alpha_p + b_p \bullet qc_K\right] + \left[\alpha_D + b_D \bullet e^{qcK}\right] + \left[\alpha_R + b_R \bullet e^{qcK}\right] \\
&= \alpha_{\mathrm{p}} + \alpha_D + \alpha_R + \mathrm{b}_p \bullet qc_K + b_D \bullet e^{qcK} + b_R \bullet e^{qcK} \\
&= R + S \bullet qc_K + (b_D + b_R) \bullet e^{qcK} \\
&= R + S \bullet qc_K + T \bullet e^{qcK}
\end{aligned}
\tag{12}
$$

(Where qc_K is the highest data quality level of user classes, $0 < b_p = S < 1, R = \alpha_p, T = \alpha_D + \alpha_R$. It is suggested that R, S and T can be assumed as constant since they should be fixed for a certain user.)

After having defined the cost function of data quality is defined, next step is to develop other two important functions are using in the allocation efficiency model. They are benefit function of data quality for service provider $B_p(QC)$ and value function model of data quality for user $V_c(QC)$. Base on above cost function model of data quality, thesis addresses some assumptions in order to generate $B_p(QC)$ and $V_c(QC)$. If an organization can avoid low data quality issues by investing money to improve the data quality, actually, they are getting benefits from the investment actions. Obviously, the benefits should depend on the biggest investment for reaching the highest data quality requirements of one of users that have the highest data quality level qc_K. Furthermore, the thesis assumes the relationship between the highest cost of data quality and benefits would be linear. The higher investment on data quality means the higher benefits that the company will obtain, which could be expressed as:

$$
B_p(QC) = B_p\ (qc_K) = bC_{qcK} = bR + bS \bullet qc_K + bT \bullet e^{qc\,K} \tag{13}
$$

(Where $0 < b < 1$, because the benefits of avoiding poor quality cost will be increased slower comparing with increased data quality investment to achieve the highest data quality level qc_K. In general, we make the reasonable assumption that benefits can be no greater than the cost. There is an important point we would like to stress is that the benefit only refers to a short term concern and with measurability.)

Another important function in the model is the value function model of data quality for user $V_c(QC)$. It is the value term for the customers. It is the monetary value that the customer obtains from the provisioning of the service. The thesis hypothesize that the value from obtaining the provided for each customer has a linear relationship with achieved data quality level qc_K. The thesis names the coefficient as D and it is should be constant for fixed user class. The value will become bigger since received quality level improved. The total obtained value of all customers should aggregate obtained value of each customer in each class.

Therefore, value function model of data quality for user classes $V_c(QC)$ can be expressed as:

$$V_c(QC) = V_c(qc_K) = D \bullet [M_1(qc_1) + M_2(qc_2) \cdots + M_k(qc_k)] \quad (14)$$

(Where M_k is the number of users in the user class k, qc_K is the data quality level for user class k.)

Since the benefit function model of data quality for service provider $B_p(QC)$ and value function model of data quality for user $V_c(QC)$ is derived, allocation efficiency model can be extended further as below. The allocation efficiency model is expressed as:

$$U_p + U_c = \alpha \bullet B_p(QC) + V_c(QC) - C_{qcK}(QC) \quad (15)$$

Apply (12) (13) (14) into (15), the allocation efficiency model can be further expressed as:

$$U_p + U_c = \alpha \bullet bR + \alpha \bullet bS \bullet qc_K + \alpha \bullet bT \bullet e^{qcK} + D \bullet \Big[M_1\,(qc_1) + M_2\,(qc_2) \cdots + M_k\,(qc_k)\Big] - R - S \bullet qc_K - T \bullet e^{qcK}$$

In order to identify the service offering QC that maximizes the sum of the provider and the customers' utilities, next step is to analyze the derivative of the function $U_p + U_c$, w.r.t. to QC and put it equal to 0:

$$\mathrm{d}\left(U_p + U_c\right)/\mathrm{d}QC$$

We can exploit it to k equations as follow:

$$\mathrm{d}\left(U_p + U_c\right)/\mathrm{d} \quad qc_1 = 0, \quad \mathrm{d}\left(U_p + U_c\right)/\mathrm{d} \quad qc_2 = 0, \quad \mathrm{d}\left(U_p + U_c\right)/\mathrm{d} \quad qc_3 = 0, \ldots \mathrm{d}\left(U_p + U_c\right)/\mathrm{d} \quad qc_K = 0$$

We concentrate on qc_K, that is, we first set the maximum quality level. The value $qc_i, (i < K)$ would be then chosen according to the customer's requirements.

$$\begin{aligned}
\mathrm{d}\left(U_p + U_c\right)/\mathrm{d}qc_K &= \alpha \bullet \mathrm{d}B_p/\mathrm{d}qc_K + \mathrm{d}V_c/\mathrm{d}qc_K - \mathrm{d}C_p/\mathrm{d}qc_K = 0 \\
&\Rightarrow \alpha \bullet b \bullet S + \alpha \bullet b \bullet T \bullet e^{qcK} + D \bullet M_k - S - T \bullet e^{qcK} = 0 \\
&\Rightarrow e^{qcK}\,[\alpha \bullet b \bullet T - T] + [\alpha \bullet b \bullet S + D \bullet M_k - S] = 0 \\
&\Rightarrow e^{qcK} = [D \bullet M_k - S \bullet (1 - \alpha b)]\,/\,T \bullet (1 - \alpha b) \\
&\Rightarrow {qc_K}^* = ln\,\{[D \bullet M_k - S \bullet (1 - \alpha b)]\,/\,T \bullet (1 - \alpha b)\}
\end{aligned} \quad (16)$$

By a given provider and a given service, the coefficient $\alpha = 0$ represents the case of isolated services, whereas $\alpha = 1$ is the case of interconnected services. Therefore, the α value should be between 0 and $1 (0 \leq \alpha \leq 1)$. In addition, αb value is also between 0 and 1 $(0 < b < 1)$, which is discussed in benefit function (Formula 13). It is easy to get $0 < (1 - \alpha b) < 1$. Therefore, the denominator of formula $T \bullet (1 - \alpha b) > 0$.

In the numerator part, the relationship between $D \bullet M_k$ and $S \bullet (1 - \alpha b)$ can be analyzed as follows.

1. $0 < b_p = S < 1$ (Formula 16), $0 < (1 - \alpha b) < 1 \Rightarrow 0 < S \bullet (1 - \alpha b) < 1$
2. $D \bullet M_k$ is the term of value function for customers, D is coefficient and M_k is the number of users in the class with the highest data quality level (qc_K). The thesis hypothesizes that the value of $D \bullet M_k$ rarely drop below 1.

Therefore, the value of numerator $D \bullet M_k - S \bullet (1 - \alpha b)$ should be bigger than *0*. According to above numeric analysis of $T \bullet (1 - \alpha b)$ and $D \bullet M_k - S \bullet (1 - \alpha b)$, the value of $[D \bullet M_k - S \bullet (1 - \alpha b)]/T \bullet (1 - \alpha b)$ can be defined, which should be above *0*. And we can always choose constant D, S, and T in order to consider qc_K* is bigger than *0*. It exactly matches Natural logarithm $\ln(x)$ function condition, which x value must be above 0.

5 Conclusion

The objective of this paper has been to introduce a new perspective on the evaluation of the optimal of quality improvement efforts for data providers. The assumptions made by previous work imply the adoption of the zero defect approach that addresses the exhaustive fulfilment of the quality requirements expressed by customers. In this thesis, we have shown how, in order to maximize the summation of the provider and the customers' utilities, the quality improvement activity and, consequently, the service offering, should privilege specific requirements.

We argue that the model presented in this thesis can be used to set a new research agenda for the definition of optimal quality offerings for service providers in multi-class data service scenarios. However, we also need to stress at least three main limitations of the model, which set the stage for further developments of the work presented in this thesis. First, although we provided a model for multi-class service provisioning, the exploitation of the utility model strongly relies on aggregating utility values. Future work should investigate more in depth how the definition of data service offerings impacts on the evaluation of the provider and the customer utility. Second, this thesis bases the definition of optimal service offerings on the maximization of the provider and the customers' utility functions. Further considerations are likely to be introduced when the definition of optimal service offerings is made on the basis of other criteria for allocation efficiency, such as Nash equilibrium. Third, the model is developed based on some assumptions. Further research should improve the model by collecting data and refine the model. Finally, an open research issue concern the assessment of the provider and the customer interests on data quality. While our model also includes the definition of subjective quality levels for customers, the utility model remains defined on the basis of objective service classes set by the provider. Future work needs to investigate the impact of subjective utility assessment on the definition of optimal service offerings for the service provider.

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A Research on the Value of the Value-Added Services of Government Information Resources

Ruo-ying Li, Wei-zhe Liu, and Tian-mei Wang

Abstract What factors will affect the value of value-added services of government information resources (GIRVAS)? Based on the perspective of cognitive theory, we propose a theoretical model of influential factors affecting the value of the GIRVAS and collect 226 valid subjects for empirical research. Customer expectation is found to have notable positive effect on the perceived quality. Also, perceived quality and ease of use have a significant positive impact on the value of GIRVAS. Customer expectation does not have a significant influence on the ease of use and scarcity does not influence the value notably.

Keywords Government influential factors • Information resources • Value • Value-added services

1 Introduction

The so-called value-added services of government information resources (GIRVAS) refers to the government or nongovernment individuals, legal entities' development and utilization of information resources owned by the government with commercial or non-commercial purposes (Tan 2007). Value-added development and utilization of government information resources can improve the knowledge intensiveness and added value of the government information resources remarkably, meet market needs, and thus improve the efficiency of production, investment and management of the whole society effectively. Therefore, research on the value of value-added services is of academic value. It provides guidance to the pricing issues in practical activities as well.

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2 Review of Related Work

Some scholars measure the value of GIRVAS from an econometric perspective, mainly employing the "perceived value" in customer satisfaction index model (CSI). As for CSI, it falls into three models: Swedish Customer Satisfaction Barometer Index (SCSB) (Johnson and Fornell 1991), American Customer Satisfaction Index (ASCI) (Fornell et al. 1996) and European Customer Satisfaction Index (ECSI) (Fishbeim and Ajzell 1975). These models mainly employ "customer expectation" and "perceived quality" as dependent variables to affect "perceived value". For instance, Yan Liu and Ying-wu Chen establish a Structural Equation Model to measure E-government Customer Satisfaction using this method (Liu and Chen 2006). Of course, some other scholars use other ideas even though adopting the Econometric structural equation modeling approach. For example, scholars such as Ying-feng Kuo explore the relationships among service quality, customer satisfaction, perceived value and purchase intention in mobile value-added services (Kuo et al. 2009).

Based on Political Economy, there are some scholars who suggest price theory of value, utility theory of value, supply-demand theory of value theory and so on, employing Marxist economic theory such as the labor theory of value. In favor of macro discussion, most of these theories are not applied in practice. Consequently, it falls short in specific references on the value of value-added services. Furthermore, these expositions are usually applied to the value of information resources and not applied to the value of GIRVAS. As a result, whether these theories can be applied in the government an information resource needs further discussion.

In addition, some scholars adopt other methods to study the issue. For example, through case research, scholars such as Flora Amato argue that the diverse in end-users and service time required leads to the differences in the forms of e-government service, so the values are different (Amato et al. 2010). Cheryl Knott Malone and other scholars believe that the complexity of information is an important aspect to measure the value of information. Based on the theory of informatics (Malone and Elichirigoity 2003), Bin You contends that the factors influencing value-added information should include: importance, sphere of action, true extent, guidance extent, ease of use and scarcity (You 2006).

3 Research Model and Hypotheses

Firstly, we refer to ACSI which is an index to measure the quality of economic output. Based on the process of product and service consumption, ACSI (Fornell et al. 1996) is a comprehensive evaluation of the level of customer satisfaction index. It consists of the satisfaction index of the whole country, department satisfaction index, industry satisfaction index and enterprise satisfaction index, and as a customer satisfaction theoretical model it is considered to have so far the most complete systems and the best effect.

Combined with customer satisfaction index model, we use the “perceived value” to measure the typical value of GIRVAS, employing “Perceived quality” as the independent variable. In Bin You’s words (You 2006), “ease of use” and “scarcity” also is important factors of the value of GIRVAS, with “customer expectation” mentioned in ACSI model. Accordingly, we believe “customer expectation” can affect “perceived quality” and “ease of use” and thus affect the value of value-added services indirectly. Consequently, we firm up four independent variables and a dependent variable for the model.

Customer expectation refers to the expectations and hopes of consumers before using the GIRVAS offered. In previous study, the relations between customer expectation and perceived quality or between customer expectation and ease of use are not taken into consideration. But we suggest that customer expectation is likely to affect perceived quality and ease of use. If the customer expectation is high, the expectation of perceived quality and ease of use will differ from that when the expectation is low. Therefore, about the factors influencing GIRVAS we hypothesize the following:

H_1: Perceived Quality Is Positively Associated with Customer expectation

H_2: Ease Of Use Is Positively Associated with Customer expectation

Perceived quality refers to the overall evaluation to the service quality by consumers in the use of GIRVAS. Fornell et al. (1996), Johnson and Fornell (1991), and Fishbeim and Ajzell (1975) notice that perceived value is positively associated with customer expectation and perceived quality in ASCI, SCSB and ECSI (Johnson and Fornell 1991; Fornell et al. 1996; Fishbeim and Ajzell 1975). We therefore hypothesize the following:

H_3: Value of GIRVAS (Perceived Value) Is Positively Associated With Perceived Quality

Ease of use refers to the availableness and convenience of information in an acceptable way when needed. Yang and Jun (2002), Srinivasan et al. (2002), Szymanski and Hise (2000) and You (2006) indicate that availability of information and the simplification of transaction process are significant factors of successful trading, which enhance the consumer’s perceived value easily. So we hypothesize the following:

H_4: Value of GIRVAS (Perceived Value) Is Positively Associated With Ease of Use

Scarcity refers to the availability of the information provided by value-added services for other consumers. You (2006) argues that scarcity is the core of the value improvement in the research of commercial activities and its most important feature is the innovation of information. Hence we hypothesize the following:

H_5: Value of GIRVAS (Perceived Value) Is Positively Associated With Scarcity

4 Methodology

4.1 Measurement of the Value of GIRVAS

In order to measure the value of GIRVAS, we use the perceived value in the theory of consumer satisfaction. Fornell et al. (1996), Johnson and Fornell (1991) and Fishbeim and Ajzell (1975) identify the variables of perceived value as "price level given quality" and "quality level given price" in ACSI, SCSB and ECSI (Johnson and Fornell 1991; Fornell et al. 1996; Fishbeim and Ajzell 1975). In the actual survey, variables used to measure the perceived value are often illustrated as the following two forms: rating of quality given price and rating of quality given price. Zeithaml (1988) notices that perceived value can be measured by the perception of "Good Value", whose essence is to survey the impact of price on the value (Zeithaml 1988). The Chinese scholars Jing-xiang Zha and Li-sheng Wang also suggest that price has a certain impact on the perceived value (Zha and Wang 2006). Therefore, the following three variables are identified to measure the value of GIRVAS:

Y1: Rating of Quality Given Price
Y2: Rating of Quality Given Price
Y3: Perception of "Good Value"

4.2 Measurement of the Factors Influencing the Value of the Value-Added Services

The literature research shows that as latent exogenous variables, customer expectation, perceived quality, ease of use and scarcity, affect the latent endogenous variable GIRVAS, to some extent. In order to carry out further empirical research, specific measurements are needed to prepare for those abstract latent exogenous variables. Measurements selected in this article and descriptions are shown in Table 1.

4.3 Questionnaire Design, Content Validity and Pilot Test

Because there is no prior study using a psychometric instrument, we developed all questions in this study on the basis of our definitions of the four core concepts. Items (i.e., questions) for customer expectation, perceived quality, ease of use and scarcity were designed with a 7-point scale. There were two anchoring points on the scale: one on value 1 and one on value 7. For example, a question was, for the money spent, I think this kind of value-added service is good enough (1—totally disagree, 7—strongly agree).

Table 1 Variables description

Latent exogenous variables	Variables	Description
Customer expectation	X11	Overall expectation to service quality
	X12	Expectation to service customization
	X13	Expectation to service reliability
	X14	Expectation to service demand
Perceived Quality	X21	Evaluation to service timeliness
	X22	Evaluation to service satisfaction
	X23	Evaluation to service error ratio
	X24	Evaluation to service process standardization
Ease Of Use	X31	Learnability of added-service operation
	X32	Available of added-service
	X33	Understandability of added-service content
	X34	Usability of added-service system
Scarcity	X41	Pertinence of service object
	X42	Innovativeness of service mode
	X43	Finiteness of quantity delivered
	X44	Finiteness of serviceability
	X45	Conversion cost

In order to ensure the content validity of the questionnaire, we asked the scholars in the field of e-government to evaluate the initial questionnaire before data collecting which centered about the contents of the questionnaire, grammar and wording. On this basis, a pilot test was conducted. In the pilot test, 63 documents were collected. We also collected the opinions of these subjects to improve the wording and to delete inappropriate questions which ensured the content validity of this study from the point of view of both theoretical and practical in a better way.

In the pilot test, we first made an exploratory factor analysis to the pre-test samples. Then KMO and Bartlett's test were adopted for determining whether the original data is fit to factor analysis using SPSS17.0. The value of KMO of standardized data is 0.704 which is greater than 0.7 and the value of P in *Bartlett*'s *sphericity test* is 0.000 which is less than 0.05. The requirements for further factor analysis were met. Afterwards, we used SPSS17.0 for Principal Component Analysis (PCA). Finally we have four factors in total.

When examining the load of testing items, loads of X43 and X44 are found relative small, which indicates that the two variables can not explain the corresponding latent variable. Thus, X43 and X44 were deleted. Seeking an account from the questionnaire, since these two measurements were suggested from the alterations of Yi-kun Xia's qualitative description (2009) (Xia 2009), there are likely problems on the question description that keeps subjects from understanding our intention. In addition, in the rotated component matrix without X43 and X44, loads of X41 is 0.473 which does not come up to the standard of greater than 0.5. If X41 is deleted, measurements of X4 will be too little to meet SEM's requirements that each factor should keep at least three measurements. So we keep X41 on the basis of former scholars' general practice.

5 Data Analysis

5.1 Basic Information of Samples

Lasting more than a month, our respondents are mainly those who have used GIRVAS. Questionnaires were sent out through paper and Internet, yielding a total of 258 document evaluations. However 32 evaluations were incomplete and had to be discarded, resulting in 226 document evaluations for use. The sex ratio of our evaluations is almost balanced (M = 51.9 %, F = 48.1 %). Most subjects are over 20 (over 20 = 94.85 %, under 20 = 5.15 %) and have university degrees or above (undergraduate = 98.9 %, Graduate = 1.1 %).

Viewed from the questionnaire design point, we have 20 measurements. With X34 and X44 deleted in the pilot test, there were 18 measurements left. Each latent variable has at least three or more variables, which conforms to Marsh's recommendation (Marsh et al. 1998). In the meantime, 226 valid evaluations obtained in the survey conformed to the general convention that the sample size is 5 times the measurements in the research on Organizational Behavior (Xu unpublished). After organizing the data, we checked if there were missing data and it turned out to be none. Further, we examined data normality. In order to ensure the accuracy of estimation results of the maximum likelihood method, we utilized the normal conversion tool of SPSS to transform raw data to normalization.

5.2 Measurement Model

According to two-step research method of Anderson and Gerbing, validation and goodness-of-fit test should be carried out as the first step before measurement modeling (Anderson and Gerbing 1988). We mainly adopt convergent validity and discriminatory validity which are widely used to test validity of measurement model at present.

We used four criteria to measure convergent validity: (a) All standardized factor loadings are greater than 0.5 and satisfy the level of significance ($p < 0.05$ or $p < 0.1$); (b) Composite Reliability (CR) is greater than 0.7; (c) Average Variance Extracted (AVE) is greater than 0.5; (d) Cronbach's α. The greater the α, the greater the internal consistency of latent variables and the reliability. It is generally accepted to be greater than 0.7 (Guilford 1965). Moreover, we employed a standard, which is that the square root of the factor's AVE is greater than the correlation coefficients of other factors, to test discriminant validity. The convergent validity of the measurement model is reported in Table 2 and the discriminant validity of the measurement model is reported in Table 3.

Table 2 The convergent validity of the measurement model

Latent variables	Measurements	Standard factor loadings	T	AVE	CR	α
Value of GIRVAS	Y1	0.67	7.61	0.66	0.85	0.84
	Y2	0.84	10.22			
	Y3	0.90	11.46			
Customer expectation	X11	0.70	7.19	0.50	0.72	0.72
	X12	0.60	5.98			
	X14	0.73	7.53			
Perceived quality	X21	0.70	7.67	0.58	0.73	0.73
	X22	0.82	9.23			
Ease of use	X31	0.67	7.49	0.53	0.82	0.82
	X32	0.73	8.41			
	X33	0.70	7.91			
	X34	0.80	9.48			
Scarcity	X41	0.86	8.98	0.57	0.72	0.70
	X42	0.63	6.55			

Table 3 The discriminant validity of the measurement model

$\sqrt{AVE}$	Value of VAS	Customer expectations	Perceived quality	Ease of use	Scarcity
value of VAS	0.81				
Customer expectation	0.53	0.71			
Perceived quality	0.75	0.63	0.76		
Ease of use	0.50	0.19	0.65	0.73	
Scarcity	0.32	0.24	0.57	0.72	0.75

5.3 Structural Model

Based on confirmatory factor analysis, hypothesis testing is done by creating a structural equation model in LISREL8.80. We arrived at the results summarized in Fig. 1. We chose 8 indicators to test the goodness of fit: χ^2 (Chi-square value), χ^2/df (the ratio of the chi-square value and degrees of freedom), RMSEA (root mean square error of approximation), GFI (goodness-of-fit index), NFI (normed fit index), NNFI (non-normed fit index) and IFI (incremental fit index). Table 4 shows the result of the goodness of fit test. The empirical research validated the hypotheses H_1, H_3 and H_4 but did not validate H_2 and H_5.

The object of this study was to identify and confirm a set of key relevance judgment criteria. We have identified four such criteria, i.e., customer expectation, perceived quality, ease of use and scarcity. The results of our exploratory and confirmatory factor analysis show that our three out of five constructs satisfy discriminant validity and convergent validity requirements.

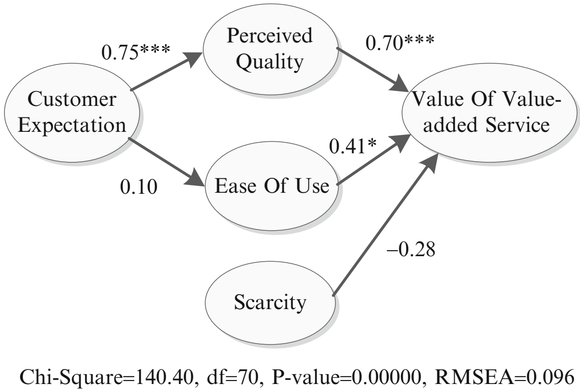

Fig. 1 Path coefficients of structural model (*p < 0.05, **p < 0.01, ***p < 0.001)

Table 4 Goodness of fit test of structural model

Indicator	Initial model	Recommended value
χ^2	140.40	–
χ^2/df	2.006	≤3
RMSEA	0.096	≤0.1
GFI	0.84	≥0.8
NFI	0.90	≥0.9
NNFI	0.90	≥0.9
IFI	0.93	≥0.9

6 Discussion and Implications

The value of value-added service is positively associated with perceived quality, which is roughly the same as the conclusions of Customer Satisfaction Index Model. Besides, customer expectation is confirmed to be a significant factor to perceived quality. Moreover, the value of value-added service is also positively associated with ease of use. Therefore, it can be concluded that the value of value-added service is positively associated with perceived quality and ease of use. Because perceived quality is positively associated with customer expectation, the value of value-added service is associated with customer expectation indirectly.

Customer expectation has no significant positive effect on ease of use, one of whose reasons may be that this item is extracted from a qualitative description of the literature and has not been actually measured by predecessors. Although the item can measure the ease of use partly, (For all related index satisfying the recommended value), trial and error is needed in actual measurement to correct. A deeper reason may be that some domestic public have perception differences on GIRVAS. Lack of information literacy and information awareness, the public doesn't have specific expectations before using GIRVAS and has no idea of what will be offered and what impact will be on daily life about GIRVAS. This also leads to the insignificance.

Scarcity has no significant positive even negative effect on the value of GIRVAS which somewhat departs from economic principle. The possible reasons are: Lack of information literacy and information awareness, the public is not sensitive to the scarcity of the value of GIRVAS. They even don't notice scarcity's existence, because we are able to obtain the government information resource services required conveniently in real life. Besides, present GIRVAS don't have the situation in which other customers are influenced because of one's using. So scarcity is not obvious for its own part. Same as ease of use, scarcity is also extracted from a qualitative description of the literature. Moreover, two of its measurements have been deleted in the pilot test and one has not reached the standard. Consequently, research on the measurement of scarcity needs further exploration.

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Network Public Opinion Information Monitoring Index System Model Research

Yi-lin Tian and Yan Zhou

Abstract Based on putting forward the information index system principles for evaluating network public opinion, this study cites the methods of the AHP, Delphi, and fuzzy complementary judgment matrix to construct network public opinion information monitoring index system and the evaluation model. By monitoring, evaluating and analyzing the "Deng Yujiao case", the validity of the model has been verified. This model manages to provide both theoretical basis and technical support for public crisis management departments in decision making against unconventional emergencies of network public opinion.

Keywords Fuzzy complementary judgment matrix • Monitoring index system • Network public opinion

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1 Introduction

The network boom provides a more efficient and convenient channel for information dissemination and a public platform for the netizen as well. The emergence of network public opinion is derived just from the platform above. The Internet has become a cultural hub of information and the amplifier of public opinion (Jintao 2008). In today's highly globalized economy, real-time monitoring and actively guiding network public opinion not only improve the government's ruling ability, but also the way the party and the government's credibility. Therefore, research on the information monitoring of network public opinion has aroused the attention of government and scholars.

Network public opinion is an influx of people's knowledge, attitudes, emotions and tendencies of behavior stimulated by a certain event via internet (Peng et al. 2007). As an important part of public administration, government has the responsibility to resolve the crisis timely and reduce the impact on the public to the minimum. Efficient handling emergencies reflects the capacity and image of government and the public's trust toward the credibility of the government as well (Hao 2009). To avoid a crisis or to solve it at the beginning is the most cost-effective and economical management method (Xiaoming 2006). Network public emergency information monitoring is an important part of crisis management of public opinion. And the rational, scientific network public opinion monitoring index system is the foundation of the overall situation analysis of network public opinion. Therefore, building a scientific monitoring index system of network public opinion and evaluating its real-time status or appraisal are conducive to provide both theoretical basis and technical support for the government to monitor network public opinion. They are beneficial to improve the government's ability to respond to crises.

The research on information monitoring of network public opinion started late in China. Some scholars have studied from different perspectives. From the perspective of sociology, Zhi-hui Peng (2008) analyzed the mass incidents monitoring and guidance of public opinion. Mu-chuan Bai (2006), from the perspective of political science, thinks that it is necessary to make an ongoing information gathering and analysis of the military network public opinion, and he established a military network public opinion monitoring system. Jun Zheng et al. (2007) and Shumin (2012) designed the overall framework of the Web opinion monitoring and reporting system. Guo-xin Tan et al. (2010), Wang Qing et al. (2011), Chen Xin-jie et al. (2012) made studies on the monitoring index system of network public opinion, however unexplored is the construction monitoring and evaluation model of net-mediated public sentiment. China is now in a period of social transition, various social contradictions have been emerged. Therefore, monitoring of net-mediated public sentiment and preventing the spread of unfavorable part become the mainly duty of government network public opinion crisis management.

Based on the above, we made research on the information monitoring and evaluation model of network public opinion, and put forward the principles of index system and set up the information monitoring index system of network public opinion. In order to prevent the defects of AHP method, fuzzy complementary judgment matrix is adopted to solve the complexity of the application of AHP. Thus, we establish the monitoring and evaluation model of network public opinion. We made use of case of Deng Yujiao to verify the effectiveness of the model. It could provide a theoretical basis for the government crisis management departments to make decisions.

2 Principles of Network Public Opinion Information Monitoring Indicator

The effectiveness of monitoring and evaluation network public opinion depends on whether the monitoring index system is scientific or not. The monitoring index is the key and core to monitoring system. Therefore, the following principles should be taken into consideration:

2.1 The Systemic and Reliability Principle

The formation and dissemination of network public opinion involve a complex system evolution. Therefore, the selected monitoring indicators should be multiple perspectives and multi-level to describe the evolution of the network of public opinion objectively. Although the index is independent from each other, the monitoring index system is an organism.

The ultimate goal of the network public opinion monitoring is to reflect the real-time evolution, and serves as decision-making for the public crisis management. Therefore, the selected monitoring indicators must be sensitive and reliable to some risk symptoms.

2.2 The Dynamic and Operability Principle

The monitoring of network public opinion is a real-time monitor among the cyberspace and grasps the instantaneous evolution trend timely. Hence, those dynamic indicators which can present network public opinion should be selected.

The network public opinion contains many uncertainties. In order to timely grasp network public opinion evolution tendency, monitoring indicators should be specific to observe.

2.3 The Sustainability Principle

Although the network is dynamic, the monitoring indexes of network public opinion are relatively stable and automatic update to ensure that the monitoring index is sustainable in terms of time.

3 Model-Related Methods

Judgment matrix is the key to AHP method. Whether it is scientific and reasonable or not has direct impact on the effect of the AHP method (Jijun 2000). However, a large number of studies indicate that the method of AHP has some defects: The calculation is huge on testing whether judgment matrix is consistent, especially when it is inconsistent and the adjustment of elements made calculation more complex. In order to solve the above problem, the fuzzy complementary judgment matrix (FAHP) is adopted in the study. The judgment matrix in AHP method is established with quantified factors by comparing the importance of factors between each pair (Zeshui 2001). While the fuzzy complementary judgment matrix is established with a given scale between 0.1 and 0.9, the description of scale is listed in Table 1.

Where $a_{ij} = 0.5$ indicates that one factor is equally important when compared with itself;

$a_{ij} \in (0.1, 0.5)$ means factor a_j is more important than a_i;

If $a_{ij} \in (0.5, 0.9)$, it means factor a_i is more important than a_j.

Weighted fuzzy complementary judgment matrix is calculated to formula (1) (Zeshui 2002):

$$w_i = \frac{\sum_{j=1}^{m} + \frac{m}{2} - 1}{m\,(m-1)} \quad i = 1, 2, \ldots, m \tag{1}$$

Table 1 0.1–0.9 scaling and description

Scale	Description
0.5	Two factors are compared, equally important
0.6	Two factors are compared, one is slightly more important than the other
0.7	Two factors are compared, one is significantly more important than the other
0.8	Two factors are compared, one is much more important than the other
0.9	Two factors are compared, one is extremely more important than the other
0.1, 0.2 0.3, 0.4	Two factors are compared reversely. If comparing factor a_i and factor a_j determines a_{ij}, then comparing factor a_{ij} and factor a_i determines $a_{ij} = 1 - a_{ij}$

According to the formula (1), the ordering vector of fuzzy complementary judgment matrix A can be obtained as $W = (W_1, W_2, \ldots, W_m)$, which is the weight matrix for the matrix A.

$$W_{ij} = w_i - w_j + 0.5 \quad i = 1, 2, \ldots, m \quad j = 1, 2, \ldots, m \tag{2}$$

The rationality of the obtained weight values in the fuzzy complementary judgment matrix should be carried on the verification of their compatibility and consistency.

If A and B are fuzzy complementary judgment matrix, thus

$$CI(A, B) = \frac{1}{m^2} \sum_{i=1}^{m} \sum_{j=1}^{m} \left| a_{ij} - b_{ij} \right|$$

known as the compatibility index between A and B, while

$$C1(A, W) = \frac{1}{m^2} \sum_{i=1}^{m} \sum_{j=1}^{m} \left| a_{ij} - b_{ij} \right|$$

is called the consistency index of fuzzy judgment matrix A, in which, W is the weight matrix of A. If $C1(A,W) \leq \alpha$, thus A has consistency, and α indicates the attitude of decision-maker. If $C1(A,W) \leq \alpha$, the fuzzy complementary judgment matrix is considered having the consistency of satisfaction. Smaller α indicates higher requirement for consistency by the decision-maker.

If $A_i = (r_{ij}^{(s)})_{m \times m}$ $(s = 1,\ 2,\ \ldots,\ n)$ is fuzzy complementary judgment matrix, thus $W_s = (W_{ij}^{(s)})$ is the weight matrix of A_i, and $W = W_{ij}$ is the weight matrix of $\overline{A}$. Where in

$$\overline{A} = \sum_{s=1}^{n} \lambda_s A_S, \quad \overline{W} = \sum_{i=1}^{n} \lambda_s W_S, \quad \lambda_S > 0, \quad \sum_{s=1}^{n} \lambda_s = 1$$

If the fuzzy complementary judgment matrix passes both compatibility and consistency test, you can adopt all the weight.

4 Model Construction of Monitoring and Assessing Network Public Opinion

4.1 Setting of Index System in the Network Public Opinion Monitoring

It is a complex problem to set up the monitoring and assessing index system of network public opinion, because it is difficult to make accurate judgment among a number of indicators. With the systematic, flexible and practical characteristics, the AHP works in setting up complex system. According to the subordinate relations among monitoring and assessing indexes, the AHP is applied to turn the complex into orderly hierarchy, which intuitively reflects the relationship between the indexes. In this study, using Delphi method, 35 peer experts, after several rounds of consultation and argument and gradually worked out the satisfactory monitoring index of network public opinion. The data is processed in the regular calculation formula for statistical indicators used in Delphi:

$$\alpha^2 = \sum\nolimits_{i=1}^{M} (a_i - E)^2 m_i / \sum\nolimits_{i=1}^{M} m_i - 1 \tag{3}$$

According to the subordinate relations among monitoring and assessing indexes, an orderly hierarchy structure is created in the AHP method. Network public opinion index system is divided into three layers. The first layer is LevelIindicators, which include six indexes. The first index, subject sensitive index, also called F1, refers to the type of information, including Public Security (natural disasters, terrorist threats, environment pollution, health and safety, ethnic conflict, black evil force etc.), corruption, political issues (issues of domestic or foreign major political events, political rumors) and public administration (mainly refers to the conflict emerged in Law enforcement of the government departments). There are public opinion release source index F2, public opinion information transmission index F3, public opinion information audience index F4, Internet users attitude index F5 and the news media attention index F6. The second layer is LevelII indicators. The F11 index stands sensitive degree to public opinion topic. The F2 index includes Public opinion information release source of dynamism degree F21. The F3 index includes Public opinion information flow variations degree F31, public opinion information evolution degree F32 and Public opinion information dissemination degree F33. The F4 index consists of BBS public opinion information activity degree F41, Twitter public opinion information activity degree F42, Blog public opinion information activity degree F43 and other public opinion information activity degree F44. The F5 index contains Netizen' attitude toward public opinion information F51, mainly refers to their emotional intensity faced up with public opinion, such as anger, excitement. The F6 index includes the quantity of net-mediated reports on public opinion F61 and the quality of net-mediated reports on them F62. LevelIIindex is composed of 12 indicators. The third layer is LevelIII indicators, including 30 indexes, see Table 2 for details. A total of 48 indicators constitute the network public opinion monitoring index system.

4.2 *Probability Distribution of Information Monitoring of Network Public Opinion*

In this study, we apply fuzzy comprehensive evaluation method to calculate the probability of network public opinion monitoring. Obtained probability value is

Table 2 Network public opinion monitoring and evaluation index system and weight

Level I	Weight	Level II	Weight	Level III	Weight
Public opinion information subject sensitive index (F1)	0.312	Public opinion information subject sensitive degree (F11)			1
Public opinion information release source index (F2)	0.106	Public opinion information release source dynamism degree (F21)	1	Information accumulated release number (F211)	0.5
				Change rate of Postings (F212)	0.5
Public opinion information index (F3)	0.073	Public opinion information flow variations degree (F31)	0.366		
		Public opinion information evolution degree (F32)	0.316		
		Public opinion information dissemination degree (F33)	0.318		
Public opinion information audience (netizen) index (F4)	0.279	BBS public opinion information activity degree (F41)	0.313	Cumulative browsing number (F411)	0.157
				Browse the rate of change F412	0.157
				The cumulative number of threads (F413)	0.211
				Thread the rate of change (F414)	0.211
				Cumulative transfer number (F415)	0.132
				Change rate of Transfer (F416)	0.132
		Twitter public opinion information activity degree (F42)	0.0307	Total number of posts (F421)	0.157
				Change rate of Post (F422)	0.157
				The cumulative number of attention (F423)	0.211
				Change rate of attention (F424)	0.211
				Cumulative transfer number (F425)	0.132
				change rate of transfer number (F426)	0.132

(continued)

Table 2 (continued)

Level I	Weight	Level II	Weight	Level III	Weight
		Blog public opinion information activity degree (F43)	0.267	Total number of posts (F431)	0.216
				Change rate of Post F432	0.216
				Cumulative reading quantity (F433)	0.096
				Change rate of reading (F434)	0.096
				Cumulative number of comments (F435)	0.076
				Change rate of number of comments (F436)	0.076
				Cumulative transfer number (F437)	0.112
				Change rate of transfer number (F438)	0.112
		Other public opinion information activity degree (F44)	0.113		
Netizens attitude tendency index (F5)	0.163	Netizens of public opinion attitude toward information degree (F51)	1	Anger (F511)	0.427
				Excite (F512)	0.306
				Detest (F513)	0.267
The news media attention index (F6)	0.067	Network media of public opinion information quantity (F61)	0.5	The media number (F611)	0.451
				Informational capacity (F612)	0.549
		Network media of public opinion information cumulant (F62)	0.5	Authority F621	0.262
				Authenticity (F622)	0.422
				Comprehensiveness F623	0.316

divided into 4 levels. Level I indicates the network public opinion monitoring probability $F \leq 0.1$, meaning the network public opinion is pretty quiet. Level II means the network public opinion monitoring probability $0.1 < F < 0.2$, it means probability is low, while the monitor should strengthen inspection and report the situation to the crisis management department. Level III indicates the network public opinion monitoring probability value $0.2 < F < 0.3$, it shows that the network public opinion information have a higher probability, and the network public opinion is turbulent, and is evolving to a more serious situation. The monitor should strengthen the alert and report the key public opinion information index of the current situation to the crisis management department for decision-making. Level IV indicates the network public opinion monitoring probability value $F > 0.3$, which means that the network public opinion information predicts high probability and reveals the trend which is likely to lead to unconventional emergencies and serious consequences. The monitor should pay close attention to the development trend of network public opinion information and report the key related index first time to the crisis management department for scientific decision-making.

5 Case Analysis

We select one of the 2009 Top Ten Network Public Opinion events "Deng Yujiao case" as a sample, so as to verify the validity of network public opinion information monitoring and assessing model.

5.1 The Determination of Index Weight

Based on the network public opinion monitoring and assessing indicator system, peer experts give an evaluation to each index of fuzzy complementary judgment matrix in 0.1 $\sim$ 0.9 scale method. Thus, we get the Fuzzy complementary judgment matrix by paired comparison for LevelIindicators as follows.

$$F = \begin{bmatrix} 0.5 & 0.4 & 0.5 & 0.7 & 0.6 & 0.4 \\ 0.5 & 0.5 & 0.4 & 0.6 & 0.5 & 0.6 \\ 0.4 & 0.3 & 0.5 & 0.6 & 0.7 & 0.3 \\ 0.3 & 0.4 & 0.5 & 0.5 & 0.6 & 0.4 \\ 0.4 & 0.5 & 0.6 & 0.7 & 0.5 & 0.7 \\ 0.3 & 0.6 & 0.7 & 0.8 & 0.3 & 0.5 \end{bmatrix}$$

According to formula (1), obtained fuzzy complementary judgment matrix, then calculate the following fuzzy complementary weight judgment matrix in light of the formula (2):

$$W = \begin{bmatrix} 0.5 & 0.502 & 0.536 & 0.476 & 0.481 & 0.426 \\ 0.461 & 0.5 & 0.472 & 0.426 & 0.514 & 0.507 \\ 0.419 & 0.461 & 0.5 & 0.472 & 0.517 & 0.415 \\ 0.427 & 0.562 & 0.421 & 0.5 & 0.426 & 0.456 \\ 0.501 & 0.512 & 0.453 & 0.521 & 0.5 & 0.522 \\ 0.516 & 0.492 & 0.465 & 0.477 & 0.431 & 0.5 \end{bmatrix}$$

According to the fuzzy complementary judgment matrix compatibility and consistency judgment principle, the result of compatibility and consistency test is $C1 = (F,\ W) = 0.0317 < 0.1$. This shows the matrix pass the test. For the sake of brevity, only one expert evaluation was adopted into computation, and other computational process is omitted. While fuzzy complementary judgment matrix made by all the experts satisfies the compatibility and consistency test, the weight of LevelI indexes is a weighted average of all evaluation. $W = (W1\ W2\ W3\ W4\ W5\ W6) = (0.312\ 0.105\ 0.073\ 0.279\ 0.163\ 0.067)$. Similarly the weights of Level II and Level III indicators are obtained, as shown in Table 2.

Table 3 Level III index values

Level III	Values	Level III	Values	Level III	Values
F11	8.5	F421	53,6832	F437	1,2127
F211	6	F422	15.9	F438	20.1
F212	6	F423	87,212	F44	93,261
F31	0.7	F424	14.8	F511	8.7
F32	0.8	F425	11,867	F512	5.3
F33	0.9	F426	13.2	F513	2.6
F411	759,636	F431	83,621	F611	87
F412	13.7	F432	13.9	F612	5,682
F413	73,947	F433	32,783	F621	3.1
F414	19.6	F434	19.1	F622	5.2
F415	27,786	F435	1,896	F623	4.6
F416	11.8	F436	19.4		

5.2 Probability Value in the Information-Monitoring Network Public Opinion

On the basis of the network public opinion monitoring index system, three-level index mainly adopted through following ways: ① those objective data, such as the public opinion information source index, public opinion information dissemination index, audience index and the media attention index, are obtained through the platform of media monitoring in the website such as people.com.cn, or Baidu search engine or influential news portals, like sina, google, sohu, etc.; ② To the subjective indicators, such as the public opinion sensitive degree, Netizen' attitude to public opinion information and the quality of net-mediated reports on public opinion, all these data sources are assessed by peer experts. To the sample of " Deng Yujiao case", we selected the timing indicators at May 20th, 12 p.m. Expert scoring results are shown in Table 3.

According to the data in Table 3, We apply fuzzy comprehensive evaluation method to calculate the probability value and the result is $F \backsimeq 0.2983$. It shows that in May 20th the "Deng Yujiao case" network public opinion probability value has reached level III. The monitor should report the seriousness of events to the crisis management departments, and provides not only the development trend of detailed indicators about public opinion information, but also the rationale for decision-making to the crisis management department.

5.3 Analysis on Operation Results

"Deng Yujiao case" verifies the effectiveness of network public opinion monitoring and assessing model established in this study. The operation result $F \backsimeq 0.2983$ indicates that in May 20th, the probability value had reached the level III, which indicates that a great net-mediated public sentiment was composed and the government crisis management departments should take emergent corresponding action to cope with it. As the matter of fact, the very next day, that is May 12th of “Deng Yujiao case”, Badong police bureau released the first case report in the official websites—Badong of the Yangtze River online information publishing platform (Xu Jinghong et al. 2010). The gap between this briefing and media reports made the events dim and results in a rush of attention from the netizen. Till May 18th, and 19th, the second and third briefing was released successively but incurred much more criticisms. The police bureau was confronted with acute network public opinion condemn, with obvious value judgment and orientation. Forced by the strong network public opinion, the local authorities began to focus on “Deng Yujiao case” and established the media centre of it. Since May, 21st, the government instead of the police acts as the spokesperson during the process of events (Zhang Jijun 2000). Thus, the case verified the information of network public opinion monitoring and evaluation of the model are consistent with the actual situation.

6 Conclusion

A scientific and effective monitoring and assessing model of network public opinion provides both theoretical and technical support to government for decision-making on emergency. In this study, we present the principles of constructing the index system of network public opinion, and using analytic hierarchy process to build a hierarchy of network public opinion monitoring indicators. It is quite complex to calculate the index weight in AHP. Therefore, the fuzzy complementary judgment matrix was adopted into the model. Application of this matrix simplified the calculation of index weight remarkably.

Finally, the case of Deng Yujiao shows that the network public opinion information monitoring and evaluation model established in the paper is reliable and operable. The model manages to provide both theoretical and technical support to government for decision-making in unconventional emergency.

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Study on the Model of Lean Arranging Course Under the Credit System

Quan-qing Li and Ming Li

Abstract Independent choosing course is the core of the credit system, and arranging course is the key to realize independent choosing course. This paper takes lean production ideas as the guidance, after analyzing the current model of choosing course and arranging course in colleges and universities, it puts forward the lean arranging course model. Firstly the courses are classified based on the demands of choosing course, and points out that the students choosing the courses mainly consider to meet the graduation requirements and personal interests, and generally would not choose course of other grade. Then, it puts forward the concept of the rejected choosing rate, and points out that the goal of lean arranging course model is to reduce the rejected choosing rate, therefore, it proposes the principle of arranging course, adopt the method of constructing course set to realize the principle of arranging course. This model can effectively solve the time conflict in choosing courses, and it can greatly improve the rate of success choosing course.

Keywords Arranging course • Colleges and universities • Credit system • Lean production

1 Introduction

American Institute of Industrial Engineers AIIE puts forward the definition of industrial engineering: Industrial Engineering is concerned with the design, improvement, and installation of integrated system of people, materials, information, equipment, and energy (Luo and Zhu 2008).

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From this definition, it can know the study object of industrial engineering is an integrated system that is composed of five elements. Colleges and universities are the integrated system that accord with the five elements, so it is the study object of industrial engineering.

Any operating system should consider efficiency, cost and quality. Colleges and universities is a complex system with "student" as the main products, and also pursuits the high efficiency, low cost and good quality. In practice process of seeking high efficiency, low cost and good quality, machinery manufacturing system created a model of lean production and formed a production planning, logistics control methods. For the colleges and universities, although they can not copy the approach of manufacturing system, the lean production thought is applicable (Zhu 2009). It is extremely necessary to guide the teaching management job with lean thinking, particularly the work of choosing and arranging course under the credit system.

2 Necessity Analysis of Lean Arranging Course

Lean arranging course, that is, under the guidance of lean production thinking, according to "make better" principle to do well the arranging course work.

2.1 Basic Ideas of Lean Production

The Massachusetts Institute of Technology made a comprehensive and profound investigation, analysis, research on many car factories in Japan, United States and Europe, and found that Japanese automobile industry's competitive edge did not lies on the degree of automation companies, the size of production volume, the number of product types, but it lied on creating the new Toyota production methods – Toyota production methods. Americans called "lean production."

Although the Americans did not give a clear definition of lean production, but they accurately interpret the meaning of the lean production.

Lean Production comes from Japan's Toyota methods of work. Lean production not only has ended the U.S. dominance in the automotive industry, but also opened up a brand new production pattern (Liu and Wang 2010).

The core idea of Lean Production is to eliminate waste and make better. From the concept of speaking, the great contribution of lean production thinking is that defines a brand new concept of "waste", it believed that all non-value-added activities are a waste of time. The concept of lean production drives the people to pursuit the perfect, and so as to derive maximum economic benefits (Yang 2009). Under the guidance of lean production thinking, people no longer satisfied with the one thing whether they can make, but to consider how to "do", the "success or failure" has become a secondary objective of assessment, the "good and bad" has become the most important goal.

2.2 Current Situation of Arranging Course Model of Colleges and Universities Under the Credit System

At present, the credit system has been widely implemented in colleges and universities of our country. Implementing the credit system in the world has the history of nearly 100 years, and the vast majority of our undergraduate colleges also used for many years. Many experts and scholars made a detailed exposition of the meaning of implementing the credit system in colleges and universities (Wang 2005; Yang 2006). (1) It provides more free space for the development of students and it is conducive to the implementation of quality education. (2) It is conducive to promote teaching reform to meet the needs of students' self-selection. (3) It is conducive to promote the contingent of teachers between teachers in the formation of a healthy competition mechanism. (4) The students can multi-disciplinary or multi-college choose their most love courses or a minor in the second professional in accordance with the teaching requirements and their ability, aspirations, and it is conducive to the development of the personality of students. (5) Because the students independently choose the curriculum, teachers, classes and learning process, it is conducive to stimulating the innovation ability of students and the cultivation of talents.

In the credit system, students that study a certain course are uncertain. They come from different grades and majors, and the number is changing, so the course arrangement under the credit system is much more complicated than the course arrangement of the academic year. It has put forward a very high capacity demand for teaching resources, such as teachers, classrooms, teaching equipments, teaching time, and the capacity is often insufficient. But sometimes there will be excess capacity situation – if the students of choosing a certain course is too few and related resources will be idle. From the practical situation, in rare cases, so this paper will not be discussed. This paper discusses how to best meet the needs of students in autonomy choosing course and to make the rejected choosing rate minimum under the certain resources available circumstances.

It can explain from the theory that the choosing course system which fully meets the needs of students does not exist (Wu 2006). In the actual work of colleges and universities, the course arrangement has become practical constraints that students select courses independently. Therefore, reasonable choosing course model is the key to realize the student independent choosing course (Xi et al. 2006).

At present, China's colleges and universities adopt several choosing systems, which are three stages of primary choosing, formal choosing and giving up choosing, then finally determine their own timetable (some of these colleges and universities will be known as the first stage, second and third choosing) (Fu and Wang 2006). There are two models from the order of choosing and arranging course to see (Xu 2004). (1) The first arranging courses then choosing courses. The model is in accordance with the mode of the academic year system, academic year and credits system to arrange courses, and students can choose courses in the identified timetable of classes. (2) The first choosing courses then arranging courses. This is an arranging course model of credit system. The school arranges the course according to student demand after the students selected the courses which are demanded by the teaching plans. The courses and teachers that the number of choosing course is more need to open the multiple classes. Both models require students to adjust its course arrangement after the choosing course, because of the reasons, such as time conflict, the number limit, suspended classes, some courses selection are rejected, to choose other courses.

The first choosing courses then arranging courses is suitable for the colleges and university that teaching resources is sufficient and the first arranging courses then choosing courses is suitable for the colleges and universities that teaching resources is relatively tight.

The two models of arrangement course, all starting from the course nature, taking the teaching resources as constraints to arrange course.

2.3 Analysis of Choosing and Arranging Course Model

The core of credit system is choosing courses (Shi 2006; Jiang 2010). The world's first birth of the credit system is from U.S., and it is developed on the basis of choosing course system. The significance of the credit system in this paper is built on the basis of choosing course system. If there is no choosing course system, these "significance" should not exist. Therefore, the implementation of the system or the size of rejected choosing rate is a touchstone to judge the true or fake credit system and evaluate their effectiveness.

Currently the vast majority of colleges and universities implement the model of first arranging course then choosing course, although it provide a convenient for students to choose courses, the students in choosing courses only consider the first choice (the most want to choice the courses), then consider other volunteers, and even choose the courses who don't want to choose but in order to earn enough credits to have to choose, because timetable has been scheduled. At present, the vast majority of choosing course system is not empowered to weight for the choosing courses. So the choosing results cannot fully reflect student volunteer; that is to say, due to schedule constraint, students have to choose part of courses of his unwillingness to learn. Course volunteers were rejected, because of learning capacity, by the restrictions of the number of learning. Most rejected choosing is because of too many students, small part of rejected choosing is because of too few in number. This has such a situation: a certain number of courses were closed because the students were too little, it will make those who firstly want to choice other course would be rejected after wanting to choose the course secondly. They not only lost their first choice, but also they lost their second volunteer. The high rate of refusal choosing is an inevitable problem in the model of first arranging then choosing courses.

From the practice of colleges and universities in recent years, the condition is also true. For example, in a university, students reflect that the rejected choosing rate is too high since having practiced credit system for 3 years. Due to rejected choosing, students cannot choose their most love to learn the lesson, so they are impossible graduation in advance. There are nearly 15,000 graduates in the 3 years, but only one student is graduated in advance. Moreover, the small number of colleges and universities under the credit system, and they abolished the system of some of the school year to another examination session and make system 4 years and not 4 years the number of graduates has increased. They are "extended system", the number slightly higher than the academic system "repeaters".

2.4 Significance (Meaning) of Lean Arranging Course

The key to implement credit system is to realize students' independent choosing course. No independence, no credit system. Therefore, judge whether the implementation of credit system is thoroughly or not, that is the degree of independent choosing course.

So-called independent choosing course, is in the framework of the teaching plan, the student is completely by individual willingness to choose course. But the school course arrangement should be restricted by the teaching resources of teachers, classrooms, class time, etc. All these restricts arrangement courses, and the arranging course restricts course selection, too, these make some students volunteer was rejected, resulting in reduced the degree of independence. This paper puts forward the concept of rejected choosing rate, to characterize the degree of independence, and at the same time to characterize the degree of the credit system implementation.

Definition of the rejected choosing rate is:

$$\text{Rejected Choosing rate} = \frac{\text{the sum of rejected courses of the choosing course volunteer and person-time}}{\text{the sum of courses of choosing course volunteer and person-time}} \times 100\ \%$$

The key of implementing credit system is to realize the students' independent choosing course. Students' choosing course is influenced by many factors, different major, the interest difference to choose course is very big, those boys and girls of the same profession, the elective interest also have very big difference (Li 2012). Therefore, to realize lean arranging course, ensure students as far as possible to choose their courses that they wish, as far as possible to make the rejected choosing rate tends to zero, fully show the meaning of credit system, is the important significance of lean arranging course.

3 Research of Lean Arranging Course Model

3.1 Partition of Course Types Based on Choosing Course Requirements

To reduce the rejected choosing rate is the goal of the lean arranging course model. When teachers, classrooms and other hardware in the school are certain, to reduce rejected choosing rate will depend on science curriculum schedule. Obviously, if students want to choose courses that can be discharged at different time, the class time of the courses that they choose do not conflict, which can reduce the rejected choosing rate. Therefore, this paper starts from the analysis of students' choosing course requirements, carry on course classification based on the choosing course demands, then to build lean arranging course model.

3.1.1 Analysis of Choosing Course Requirements

Students choose the courses mainly considering two factors (Tao et al. 2006): one is from the graduation requirement or the view of interest to decide to choose the courses, the other is after they choose courses, then choose the teachers of teaching the courses. The former will be known as the choosing courses, and the later will be known as the choosing teachers. The situation will exist for the reason that like teachers to choose the courses, but these must be the courses that definitely not affect the graduate or little interest, this paper do not discuss.

Because they have more students who are interested in and more teachers teaches them, we called the situation of many teachers teach many students in some courses as more than the beginning of classes. Some teachers opened a door courses, classes for the students, divided into several classes to school, will be a lesson for more than a teacher of the class known as the beginning of the first multi-course commenced. Although each semester there are tens of thousands of students from thousands of courses to choose, but in reality is not every student to choose this may be a few thousand doors. For a student, these lessons on the importance he has different the first voluntary choice of each semester's class is for those who cannot change the compulsory course, these courses can guarantee he graduated. The second is from voluntary and professional point of interest in classes, if not elected can choose other.

Contrast of the grade of academic year system, still use freshman, the second to describe the beginning. Elective students, if elected other "grades" of course. General elections are adjacent grade, students such as sophomore or junior elected freshman class. The vast majority of students across grades and classes will not, for example, junior students will not elect freshman course, the freshman also will not choose the junior courses. For simplicity's sake, we call freshman and three grades as junior-grade, second and four grades as a senior 2-year.

3.1.2 Course Types

This paper only discusses the arranging course model of theory courses. In the teaching plan, the courses will be divided into different types. In some colleges and universities, the courses are divided into three types of compulsory course and restrictions elective, arbitrary elective, but also have some colleges and universities, the courses are divided into six types of public foundation, disciplinary foundation, major, professional elective, expending elective, public elective. The second classification is the refinement of the first one. Thereinto, the public foundation, disciplinary foundation and major are compulsory courses, the major elective, expending elective are restrictions electives (the choice space is very small), the public elective course is the arbitrary elective (choice space is very big, basic unlimited). This kind of classification is called as curriculum types of teaching plan.

For the requirement of arranging courses, this paper from the perspective of teaching object, analyzes the courses. The Ministry of education, 2012 edition, the undergraduate major content of common colleges and universities, the major will be divided into three level of discipline class, professional class, major. Generally speaking, the colleges and universities set up with multiple disciplines and dozens of professional class, and more majors, and the courses are suitable for different major. In summary, from choosing course, choosing teacher, more teachers, more classes, the number of students to classify the courses, such as Table 1.

3.2 Study on Lean Arranging Course Model

Lean production thought of "eliminate waste, keep improving" is introduced into the choosing and arranging course model. To achieve excellence, that is to mostly meet the needs of independent choosing course of students, make rejected choosing rate tend to zero; eliminating waste is the most efficiently utilize teaching resources, for example, under the premise of guarantee reasonable number of classes, reducing class number is to reduce waste. The model of choosing and arranging course under the guidance of lean thinking, is called as lean arranging course model. It's goal is, in a certain resources of school hardware and teachers, scientifically arrange the schedule, try to reduce class time conflict of students to choose courses, in order to meet the demands of independent choosing course of students, as far as possible to reduce the rejected choosing rate.

3.2.1 Course Code

The course code in lean arranging course model, add code segment of identifying course type and teaching object. As shown in Fig. 1:

In Fig. 1, A is the course type code, the relationship of its values with the course types is shown in Table 2:

Table 1 The undergraduate major content of common colleges and universities

Type of course		Professional restrictions	Course election	Teachers election	More classes	More first class	The number of classes
Compulsory	Public basic course	Basically suitable for the professional	No	Yes	Yes	Yes	More
	Subject basic course	The same categories of professional	No	Yes	Yes	Yes	Less
	Courses	The professional	No	No	No	No	Little
Limited elections	Professional elective course	The professional	Yes	No	Basically does not exist	Basically does not exist	Little
	An inter-professional elective course	The same general category of professional disciplines	Yes	Yes	Basically does not exist	Basically does not exist	Less
Optional	Public elective course	All Professional	Yes	Yes	Yes	Yes	More

Fig. 1 Course code

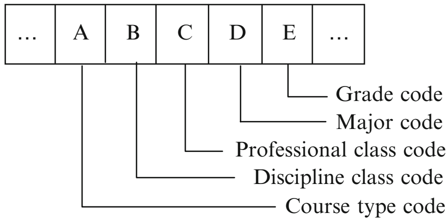

Table 2 Course type code A

Code	Course type
0	Public basic course(compulsory, suitable for all majors)
1	Public basic course(compulsory, suitable for discipline class 1)
2	Public basic course(compulsory, suitable for discipline class 2)
3	Public basic course(compulsory, suitable for discipline class 3)
...	...
A	The public elective course (no groups)
B	The public elective course (group 1)
	The public elective course (group 2)
	The public elective course (group 3)
...	...
T	expending elective course
X	Discipline basic course
Z	Major course and professional elective course

Generally speaking, public basic courses are the compulsory course, some are suitable for all majors, some are suitable for part of majors; Public elective courses, some are not suitable for grouping, some are suitable for grouping (such as sports, fine arts, literature, etc.), for these courses, with the code to distinguish.

Coded B, C, D respectively use $0 \sim 9$ and letters A to Z to express different disciplines, professional class, major.

Code E uses $1 \sim 4$ to express start classes time, 1 represents grade one, 2 represents grade two, and so on.

3.2.2 Principle of Arranging Course

For analyzing problems conveniently, the time that can be able to arrange once class is called as an arranging course unit, such as colleges and universities often arrange once class with 2 h together, the two hours is called as a unit.

From the choosing course point of view, if all courses that a student is willing to choose are arranged in the different arranging course units, the choosing demand of the student can completely satisfy, for him, the rejected choosing rate is zero. Hence, can be determined

	rule	illustration
1	If A=0. choose E non-adjacent courses	; Public basic course, suitable for all majors
2	If A is digit, choose A different course, and E non-adjacent courses	; Public basic course, suitable for specific disciplines
3	If A=A, choose E non-adjacent courses	; Public elective course, no group
4	If A belongs to B ~ S, choose A different course, and E non-adjacent courses	; Public elective course, there are groups
5	If A=T, choose B different course, and E non-adjacent courses	; Expanding elective course
6	If A=X, choose B different course, and E non-adjacent courses	; Discipline basic course
7	If A=Z, choose Z different course, and E non-adjacent courses	; Major course and professional elective course

Fig. 2 Constructing rule and process of course set

Principle of arranging course: the courses that some particular students can choose do not arrange in an arranging course unit.

According to the principle of arranging course, can be obtained:

Ratiocination: in an arranging course unit, the courses that some kinds of students would like to choose are at most only one.

3.2.3 Construction of Course Set

For lean arranging course model, the key is to construct the set in an arranging course unit. The set conforms to the ratiocination of the arranging course principle, in a arranging course unit only provide a course that certain types of students are willing to choose. Therefore, it can be based on A ~ E segment of the course code to construct course set, the courses of the set all meet the rules. Rules and process are shown in Fig. 2:

In an arranging course unit, just arrange the courses in a set, which realizes the arranging course principle and ratiocination.

Courses in set 1 are less, but there are more teachers to start classes, the students of choosing course are more, the teachers of starting classes are more, so more teaching resources can be used.

3.3 Analysis of Rejected Choosing Rate

Capacity and demand is a contradiction. The rejected choosing rate is not only proportionate to the difficulty of arranging course, but also determines the reasonableness of the timetable. The low rejected choosing rate will inevitably lead to the timetable unreasonable; and even the course is ranked in rest days. This is not only because the timetable row is not easy, the mainly reason is that will open more courses and arrange more classes to meet student demands. When teaching resources in a certain, the school had to occupy the night and rest days, even could not meet the requirements of the beginning.

For a arranging course unit, relative to the teaching resources of time, teachers, classrooms, if we can construct the course set with proper capacity, it can be achieved that rejected rate is zero. But the work of arranging course is actually very complex, it is impossible to construct such set in all cases, in some arranging course units, more sets had to arrange courses at the same time, this violates the arranging course principle and ratiocination, there will be rejected choosing. However, because of the complexity of arranging schedule of work, school resources are unlikely to fully meet the needs of students in choosing course, no rejected choosing rate is not possible. The purpose of lean arranging course model is to reduce the rejected choosing rate.

4 Conclusion

Lean arranging course model is obtained based on analyzing the characteristics of courses and the student choosing course, it can solve the time conflict during choosing course, and it can greatly reduce the rejected choosing rate.

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Part X
Management Sciences – Organizational Management

Research on the Classification and Constitution of Knowledge in the Manufacturing & Machining Process of Flow Industry

Yong-fan Li and Jing Wang

Abstract Considering the balance between integrity and flexibility of knowledge management in manufacturing & machining process of flow industry, knowledge cell could be defined according to different status of on-the-make product. Then, a generalized knowledge constitution model is brought forward with the classification of knowledge into three aspects: knowledge cell, relationship knowledge, and process knowledge.

Keywords Flow industry • Knowledge cell • Knowledge classification • Manufacturing process

1 Introduction

Since the 80th of last century, Knowledge Management, as a concept accompanied by knowledge economy, has been attached much importance and developed a series of tools with the development of communication and computer technology. Being an essential strategic resource of enterprise, knowledge plays more and more important roles in the process of enterprise operation. Based on information technology, Knowledge Management System has been introduced and taken effect in all industries, especially traditional manufacturing industry. However, the application of knowledge management in flow industry is remarkably different from that in traditional manufacturing industry, because of its own characteristics.

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This paper focuses on the manufacturing & machining process of flow industry and discusses about the methods of knowledge classification, and then brings forward the organization and constitution pattern of knowledge, which is expected to make some contribution for the effective knowledge management of enterprise.

2 Knowledge Management and Knowledge Classification

Based on the thoughts of several genres, the concept of knowledge management could be described as follows:

Knowledge management is such a process that community knowledge and skills are grasped and distributed into the most-output points of enterprise. The aim of knowledge management is to make organization members acquire needed information and knowledge rapidly and expediently, that is, to transfer the right knowledge to the right man at the right time in order to make the best decision. Knowledge management should be used to improve innovation skill, response ability, and productivity of individual, section, and organization (Maryam et al. 2001).

Knowledge management emphasizes the integration of knowledge contained in interior &exterior environment of enterprise and the development of self-improvable system, which could offer help for the effective communication, forecasting, and decision-making. The appearance of knowledge base and expert system provides technology support for the realization of knowledge management. Basically speaking, knowledge base system and expert system should include:

- All functions of database, including efficient storage, data sharing, data safety, parallel control, fault recovery, and etc.
- The functions of knowledge storage and management;
- The abilities to deal with knowledge by inference module (the core of knowledge base system) (Wang et al. 2009);
- A rule base and an inference level, except for RDBMS (Related Database Management System)
- The abilities to storage and manage adequate facts and rules (Li et al. 2005);

When transforming domain knowledge into exportable and feasible resource, knowledge classification will be needed to analyze the relationship and structure of different knowledge. Lots of classification methods have been brought forward in literatures. From the macroscopical point of view, knowledge could be divided into interior knowledge, exterior knowledge, knowledge life-circle, tacit knowledge, and explicit knowledge (Nonaka 1994); based on realization pattern, knowledge could be divided into domain knowledge, inference knowledge, and task knowledge (Zhu et al. 2002). The classification of knowledge will decide the integrity and efficiency of knowledge management frame directly. Therefore, effective knowledge classification will not only help enterprise manage its contained knowledge more efficiently, but also improve the flexibility and analysis ability of knowledge base.

3 The Classification and Constitution of Knowledge in the Manufacturing & Machining Process of Flow Industry

Comparing with traditional scattered manufacturing industry, the most remarkable characteristic of flow industry is the difficulty in compartmentalizing Work Cell & Work Center. In scattered manufacturing industry, work center could be defined according to individuals, workstations, or the whole assembly line. Each work center shares independence, stabilization of knowledge structure, and specialization of knowledge. Based on different craftwork process and work center, enterprise could set up and integrate Knowledge Cell to describe the whole manufacturing & machining process and develop knowledge base system.

However, in flow industry, there exist difficulties in compartmentalizing work center because of the continuity of product manufacturing & machining process. To be sure, we could set up knowledge base model based on the whole pipeline, which could make it easier to integrate and maintain knowledge base, while the flexibility and innovation ability would be depressed. Furthermore, this method tends to produce mass of redundancy. Thus, it is important to pursue balance between integrity and flexibility, that is, obtain the needed flexibility and guarantee the system integrity simultaneously. A kind of method will be introduced as follows, which could be used to compartmentalize the manufacturing & machining process of flow industry effectively.

The manufacturing process of flow industry is closely correlative with the characteristics change of product &material. The modification of predefined parameter or material amount would make influence on the chemical or physical characteristics of product and material. Defining knowledge cell according to different status of on-the-make product will be helpful to compartmentalize involved knowledge in manufacturing & machining process effectively, and provide a powerful base for the development of knowledge base system. The description of product status could be realized by clustering method. In traditional scattered manufacturing industry, part or accessory is the basic unit of clustering and clustering is conducted according to the comparability of each part or accessory (Zhang et al. 2013); while in flow industry, considering the continuity of manufacturing process and time dimension, on-the-make product could be divided into several relatively stable statuses according to the change of each parameter and its influence on product. When the manufacturing & machining process is relatively simple, knowledge cell could also be defined by the change of status caused by the increase of raw material or assistant material. The compartmentalization of manufacturing & machining process and knowledge cell shows as Fig. 1.

Knowledge cell compartmentalized in Fig. 1 is not completely independent. The modification of one status or one parameter is probable to induce the change of several statuses or even the whole process, and thereby cause the emergence of new knowledge. Furthermore, this kind of method could not contain all knowledge involved in manufacturing & machining process. Some rules and regulations which

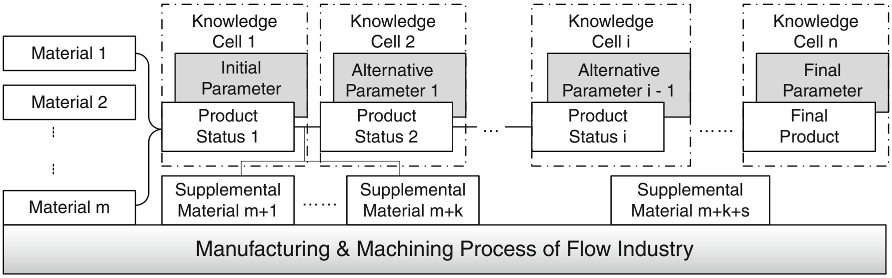

Fig. 1 Knowledge cell compartmentalization of manufacturing & machining process

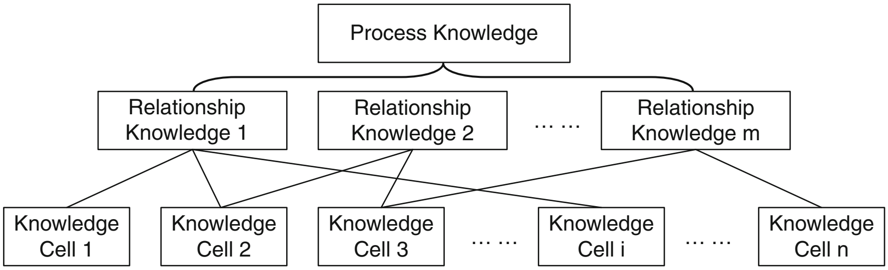

Fig. 2 Knowledge system of manufacturing & machining process

represent the relationship of each knowledge cell should be extracted and managed independently, such as, which statuses of craftwork would be influenced by the modification of "Product Status i", how many statuses would change if a parameter in process adopts another value, and etc. Such knowledge could be defined as Relationship Knowledge (expressing the relationships between several statuses) and Process Knowledge (about the expression of the whole process).

Thus, Knowledge Cell, Relationship Knowledge, and Process Knowledge constitute knowledge about manufacturing & machining process in knowledge base (Guo et al. 2002; Li et al. 2011). The relationships among them show as Fig. 2.

According to this classification, knowledge in manufacturing & machining process could be decomposed into relatively independent knowledge cell in each level, and the relationship of each knowledge cell is expressed by Relationship Knowledge. When setting up knowledge base, it is important to describe knowledge cell felicitously, that is, transform knowledge into such a language that computer could accept and storage. Documentation description is a widely accepted method, by which every kind of experienced knowledge could be coordinated and new knowledge could be inspired rapidly. However, a powerful searching engine and inference module would be needed to support the description and management of Relationship Knowledge. Extension Theory (Cai et al. 2010) also provides us useful references in this area.

4 Conclusion

Based on the characteristics of manufacturing & machining process of flow industry, this paper analyzes the classification of knowledge cell, and brings forward a constitution pattern of knowledge. Indeed, the effective management and realization of highly-abstract knowledge with the help of advanced technology still attracts lots of attention. And the decomposition and integration of process knowledge and knowledge cell is worth more research in the future.

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Organization Cycle and Evaluation of Its Flux and Capability

Zhi-qiang Zhao and Ye-zhuang Tian

Abstract It is vital for organization management to harmonize their mutual force and relations in workers or departments. Traditional organization management is used to disjoining force and counterforce in organization and studying them separately. In fact, force and counterforce is a whole which symbioses and interacts each other. Force and counterforce form a closed cycle. From this cycle system, people can study organization better than before. It is helpful for organization management to evaluate its flux and capability. The researchers can evaluate flux from forward flux, backward flux and system flux. The evaluation of capability can be processed from balance, robustness and smoothness.

Keywords Cycle • Capability • Evaluation • Flux • Force

1 Introduction

Traditional organizations are seen as a means of delivery to complete the goals and objectives or to be a force to resist the destruction of human cooperation which is the ultimate goal of the mechanism (Scott 1961). The former leads to the division of labor, because "the division of labor seems to make the largest improvement in the level productivity and labor skills and judgment play a greater role in the work" (Smith 1994); the latter organizations tend to reduce conflict and uncertainty, increasing the stability of interpersonal relationships, which requires "to establish a communication and control networks between the core and around the work" (Gulick and Urwick 1937). Therefore, the organization management includes the division of labor and coordination of work of two parts, which management

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scientists had been defined to the organizations. Robert V. Presthus defined the organization structure of interpersonal systems, and the individuals based on power, status and role separated forms of interaction has also been set down, when the ambiguity and spontaneous deducted, the desired purpose will be reach (Presthus 1958). Richard L. Daft defined organization as the four points: social entities, having an identified target, well-designed structure and coordinated activity systems associated with the external environment (Daft 1999).

The human expects to split 2 into $1 + 1$ to achieve the affect of $1 + 1 > 2$. "When our related work put together and separate unrelated, we may with a minimum price to win the biggest gains" (Chandler 1962). Therefore, from the division to the coordination of labor can be closed loop of part and whole, while the "the loop optimization of "division-coordinating" is the objective of the study of organizational theory. Since Adam Smith in 1776 published his famous "Wealth of Nations", the book for the division of labor have been given sufficient attention. Frank, B. Gilbreth and Lillian M. Gilbreth recommended classification system used in all kinds of work, and in the text of "work elements", they studied a series of "real elements", and presented a detailed classification (Gilbreth and Gilbreth 1924). However, since the organization of researchers more emphasis on the coordination of efforts.

Work coordination is the organization of the interaction between the subsystems caused by the force. Luther Gulick fall work coordination methods into two categories: organizational coordination method and the concept of Co-ordination Act (Gulick and Urwick 1937).

The organization coordination makes internal relationships tend to be reasonable through the adjustment of organizational structure. This study are been made from the division of labor, class and functions, structure, control the magnitude of the four pillars of classical organization theory, and the informal role of the neo-classical theory to system theory of the modern organization theory (Scott 1961; Brech 1957; Allen 1958). In the 1990s, people are turning their attention from the corporate sector coordination transferred to the business process coordination, and then more attention shift from the internal coordination to external coordination, including the role coordination between enterprise and enterprise and the environment. The former related theories include supply chain, supply network theory, and the latter includes the theory of corporate ecology, recycling economy.

Luther Gulick described the concept of coordination as establishing a belief in the hearts of all participants so that they stirred up the passion for work and played a creative, conscious personal behavior into the overall work (Gulick and Urwick 1937). This is actually a prototype of motivation theory, which the individual external force to change by changing the individual's work creed. Individual motivation can not be ignored in the human society. Abraham H. Maslow defined the needs of the community as high-level demand (Maslow 1943), two-factor of F. Herzberg theory, equity theory of J. S. Adams see the social as its theoretical premise. Team motivation is further seem the team as a whole in order to motivate through the promotion of cross-catalysis between the team members to achieve organizational goals (Bing et al. 2003).

Work coordination method and the concept coordination method all based the existing division of labor coordinate the relationship between departments or employees. In 1990s, the rise of business process reengineering and modularity break through this method. Business process reengineering theory stresses on the basis of existing organizations and the problems, which is "the fundamental rethinking and thorough re-design of enterprise business processes, so that the performance improved could be reflect in cost, quality, service and speed" (Hammer 1990; Hammer and Champy 1994). This is the recycling based on the traditional "labor division–coordination" circulation, and the goal is to disrupt and reallocate the existing internal relations. Modularity then is a subtotals or further decomposition process in the existing organizational departments (Baldwin and Clark 1997, 2000). This is the second cycle in the circulation of the traditional "labor division-coordination, and the goal is to sort out the existing internal relations and distribute secondary.

The study of the formation, development and management of organization above can be found in tissue: the development process of the organization is actually a loop optimization process of "labor division-coordination", and the optimization focus on the internal and external role of coordination. Therefore, the clear line of organizing theory of evolution could be resulting:

1. The development route of organization theory is thinking and optimization the entire circulation of "division-coordination" within the coordinated development of the internal organization the role.
2. The development route of the organization coordination theory turn the coordination role of the corporate sector to the role of business process coordination, and then through the supply chain (network), the management turns into the coordination of internal and external role. Recently, natural environment is bright into the system to coordinate the relationship of the whole ecosystem.
3. The development route of the coordination theory instead the individual-based incentive of society-based incentives, and then turn the individual incentives into the team incentives, and achieve the incentive goals through the catalytic within the team interaction.

2 The Circulation Role of the Organization

2.1 The Proposal of the Organization Cycle

Through the study of organizational theory, the existing organization theory focus disproportionately on the force of coordination, including the modern process management thinking, but also the management of the vector force along the flow line. According to Newton's Third Law, the interaction between objects is mutual. Object A acts object B, object B will also react object A. Overall, A and B, and

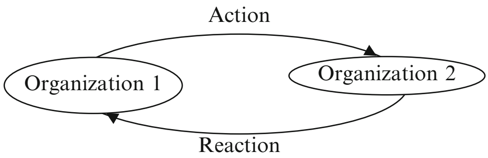

Fig. 1 The circulation role of the organization

between the force and the reaction form a closed loop. Social organization is also true. Any two social organizations or people, as long as their interactions, regardless of the force is strong or weak, the effect of good or bad, can constitute a closed loop, as shown in Fig. 1.

Existing organization theory is more concentrated in the interaction between the organizations, but there is little concern the reaction force. The reason is because researchers are accustomed to study the two forces separate, such as marketing theory is the study of the forces of corporate customers, while CRM stressed that the reaction of customers of the organization. Action and reaction, in fact, is a whole and indivisible, and the study either of them should be well thought out the other, so as to truly grasp the system as a whole, to improve the correctness of the solution to the problem.

This paper will focus on the work in this area. In this study, the reaction force would be mentioned of equal importance as the action, and all the problems are all base on the action, reaction forces and actors in the system. The paper sees organization cycle as circulatory system posed by the social organization between the role of process and reaction process. Among them, the organizational single loop circulatory system formed by the interaction by the two organizations; super cycle circulatory system is known as the organization gathered together by a number of organizational single loop circulatory system. The below will be the circulation flow and performance evaluation study.

2.2 *The Loop Elements of Organize*

1. Unit. The unit is the executor and promoters of the organization loop, and it could be people, departments/jobs or team, and also could be the lower levels circulatory system of organization. The role of the unit through a series of operational behavior turns input into output from the last unit, and spread to give the next unit.
2. Operation. The required steps of the unit take actions. Every operation needs a specific unit to execute it, and a unit may contain a number of businesses.
3. Import and Export. Import is received by the unit from outside the unit element, which embodies the results of an external unit; Export unit for processing the input, concurrent to the external elements, it reflects the role of the unit to external results.

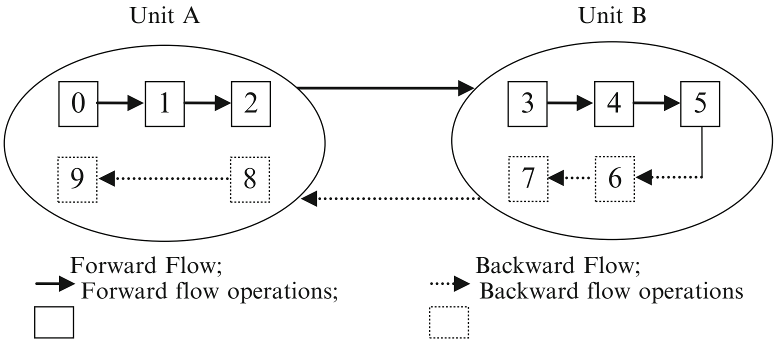

Fig. 2 The flow of the organization circulation

4. Flow. The elements flow process in the unit or business. Elements include physical, financial, and information. Flow is a vector, and its direction and business processes in the same direction. Based the flow direction, the internal flow of the cycle of organize could be divided into forward flow and backward flow, and then recycling unit operations into the forward flow operations and backward flow operations, as Shown in Fig. 2.

3 Cycle Assessment Principles of the Three Organizations

1. Systemic principles. Evaluation index system must reflect the composite system, in order to seize the main factor, not only reflect the direct effects, but also reflect the indirect effects.
2. Universality principle. The index system should be applicable for all organizations circulatory system, and it should have general applicability and representativeness.
3. Relativity principle. The indicators should reflect the corporate circulatory system from different perspectives, and be independent of each other, does not contain, do not overlap, there is no causal relationship.
4. Testability principle. Operating language could define the evaluation of definitions clearly, and the data need to facilitate the collection and analysis, in order to obtain a clear conclusion.
5. Qualitative and quantitative binding principles. Qualitative indicators compensate for the lack of simple quantitative evaluation and the inherent defects of the data itself, so that is more comprehensive evaluation. But it is certain subjective and not accurate as qualitative indicators, objective, so the two should be used in combination.

4 Flux of Organization Cycle Assessment

The Flux of Organization Cycle is in a period of time the flow and process the number of elements of organization cycle. Shown as in Fig. 3, it can be studied the loop flow problems of the organization in three angles just as forward flow, backward flow and circulation system flow.

4.1 Flux of Forward Flow

Flux of Forward Flow is the number of elements flow from unit A starting the flow of jobs to unit B completing the flow of operations during the process. In this paper, unit and system flux of forward flow indicators are the two angles of study.

1. Flux of forward flow indicators of unit A

   - Input Flux of unit A forward flow. Forward flow operators of unit A received all the number of external input and the express the formula:

$$F_{rqa} = \sum_{d=0}^{\beta} g_{rqa}(x_d) \tag{1}$$

   In the (1), x_d: the elements of d;
   $g_{rqa}(x_d)$: before the forward flow, unit A received the input quantity of d;
   β is an integer.

   - Output flux of unit A forward flow. It is the quantity from unit A taken action sent to B, and the express the formula:

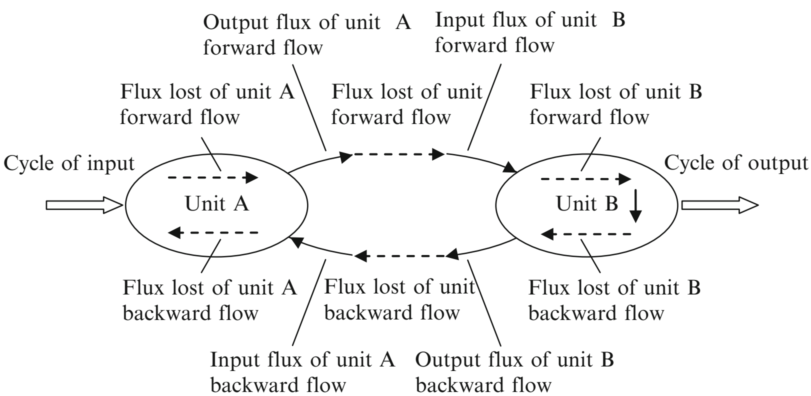

Fig. 3 The flux of organization cycle

$$F_{cqa} = \sum_{e=1}^{\delta} g_{cqa}(x_e) \tag{2}$$

In the (2), x_e: the elements of e;
g_{cqa} (x_e): unit A the output quantity of e after taken action
δ is an integer.

- Theory output flux of unit A forward flow. Based on the operation ability of unit A and the input, there are output Flux of unit A forward flow theory, and the express the formula:

$$F_{cqa0} = \sum_{e=1}^{\varepsilon} g_{cqa0}(x_e) = F_{rqa} \bullet N_{qa} \tag{3}$$

In the (3), $g_{\,cqa0}$ (x_e): Theory output flux quantity of e of unit A forward flow;
N_{qa}: The operation ability index of unit A forward flow, which is the forward flow unit input performance of the unit A that can be obtained from the analysis of empirical data;
$\varepsilon$is an integer.

- Flux lost of unit A forward flow. It is the flux lost quantity of unit A forward flow, and the express the formula:

$$F_{sqa} = F_{cqa0} - F_{cqa} = \sum_{e=1}^{\varepsilon} g_{cqa0}(x_e) - \sum_{e=1}^{\delta} g_{cqa}(x_e) \tag{4}$$

In the (4),ε, δ is an integer, and $\varepsilon \geq \delta$.

2. Flux of forward flow indicators of unit B
In addition to the output flux of forward flow of the unit A, unit B may also receive input from other organizations in the external, and unit B would complete joint effects of these inputs, forward flow operations. Because of the object of this study is the forward flow of unit B, assuming that the external input of other organizations is a constant to meet the operational requirements of unit B before flow.

- Input flux of unit B forward flow. Forward flow operators of unit B received all the number of external input and the express the formula:

$$F_{rqb} = \sum_{e=1}^{\eta} g_{rqb}(x_e) \tag{5}$$

In the (5), x_e: the elements of e;

$g_{rqb}(x_e)$: before the forward flow, unit B received the input quantity of e;
η is an integer.

- Output flux of unit B forward flow. It is the quantity from unit B taken action, and the express the formula:

$$F_{cqb} = \sum_{i=1}^{\lambda} g_{cqb}\left(x_i\right) \tag{6}$$

In the (6), x_i: the elements of i;
$g_{cqb}\ (x_i)$: unit B the output quantity of i after taken action
λ is an integer.

Theory output Flux of unit B forward flow and flux lost of unit B forward flow is similar to unit A.

3. System flux of forward flow
The forward flow system includes all the unit A and unit B operation of forward flow.

- Input system flux of forward flow. Forward flow system receives all the number of elements from outside the system, including the external input system that unit A and unit B receives. Expression formula is:

$$F_{rq} = \sum_{j=0}^{\pi} g_{rq}\left(x_j\right) \tag{7}$$

In the (7), x_j: the elements of j;
$g_{rq}(x_j)$: the quantity of j that The forward flow system received from the outside;
π is an integer.

If the quantity that unit B received is zero, system flux of forward flow is the unit A flux of forward flow.

- Output system flux of forward flow. Forward flow system outputs all the number of elements, including the output flux of forward flow of unit A and unit B. Expression formula is:

$$F_{cq} = \sum_{k=1}^{\theta} g_{cq}\left(x_k\right) \tag{8}$$

In the (8), x_k: the elements of k;
$g_{cq}(x_k)$: the quantity of k that The forward flow system output;
θ is an integer.

If the quantity that unit A output is zero, system flux of forward flow is the unit B flux of forward flow.

Theory output system flux of forward flow and flux lost of system flux of forward flow is similar to cycle unit.

4.2 Flux of Backward Flow

Flux of backward flow refers to the number of elements perform reflow operations from unit B output backflow unit A to receive the return of processed reflux flow. The reflux flow return unit flow indicators and return flow index two systems. The method of calculation of each indicator is similar to the process flow, the paper is not going to describe.

4.3 Flux of Organization Cycle System

Flux of Organization Cycle System refers to the flow quantity of the element caused by the interaction between the circulatory system and the external environment, including the circulatory system input of the organization, the output of the circulatory system, circulatory system theory output and the circulatory system loss of the organization.

1. The circulatory system input of the organization. It is that the circulatory system of the organization received the number of elements from the external environment, which includes all the elements received from outside the loop in the unit A and unit B in the forward flow and backward flow process. The formula expression as:

$$F_r = \sum_{m=0}^{\tau} g_r\,(x_m) \tag{9}$$

   In the (9), x_m: the elements of m;
   $g_r(x_m)$: the input quantity of m;
   τ is an integer.

2. The circulatory system output of the organization. It is that the circulatory system of the organization output the number of elements to the external environment, which includes all the elements output outside the loop in the unit A and unit B in the forward flow and backward flow process. The formula expression as:

$$F_c = \sum_{p=1}^{\xi} g_c\left(x_p\right) \tag{10}$$

In the (10), x_p: the elements of p;
$g_c\ (x_p)$: the output quantity of p;
ξ is an integer.

Theory output cycle system and flux lost of cycle system is similar to cycle unit.

5 Conclusions

This paper studied the circulation role of organizations and its flow and performance evaluation. Conclusions and significance are as follows:

1. Adding a new point of view. Systems thinking tell people see the problems as a whole, but people usually think of the overall system structure as a whole, while the action and reaction are used to separate analysis. This thesis attempts to change this behavior, action and reaction as interdependent and influence each other as a whole to look at, the study of change and the law.
2. Interaction of the organization, action and reaction between them can form a closed loop, and feedback loop is a common form. According to the number of participating units can be divided into a single cycle and super cycle, including round robin circle of the simplest form of organization. The elements of the organizational cycle including unit operations, input/output, flow.
3. In this paper, the circulation flow and performance indicators of organization study. Organizational loop flow problems could be studied in three angles as forward flow, backward flow and circulation system flow. Organization cycle performance evaluation includes the balance indicators of organizational cycle, robustness indicators as well as the smoothness index, which smoothness can be measured from the damping coefficient, the permeability of the corresponding three angles.

Hope that this thesis can not only enrich the existing organization theory, organization management can also provide some reference.

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Analysis Methods of Improve the University's Anti-corruption System Execution

Zhi-tong Shang, Yue-ning Zang, Wei-feng Yu, and Su-dan Wang

Abstract Anti-corruption system construction is the important part of the university anti-corruption and punishing and preventing corruption. At present, anti-corruption institutional framework of higher education system is basically completed, but the exaction is insufficient. We have to explore the effective means of improve the university's anti-corruption system execution actively, improve the system's intrinsic value enhance the external environment of the execution system and establish mechanisms to ensure implementation of the system.

Keywords Anti-corruption • Execution • Regime • Universities

1 Introduction

Since the 17th congress of Communist Party of China, Party central committee strength the intensity of building anti-corruption system. Guided by the spirit of the Central, universities attaches great importance to strengthen the system construction and formed a number of productive rules. The framework of anti-corruption is basically completed and it effectively promoted the anti-corruption in depth. But because of historical and practical reasons, the implementation of the system is not enough. There is still a large number of orders and prohibitions, to avoid execution, distort execution, choose to implement, a passive implementation (Zhong Sanyuan 2010).

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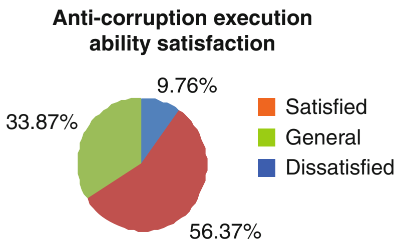

Fig. 1 Anti-corruption execution ability satisfaction

Table 1 statistics of weak enforcement of anti-corruption system

Choice	System itself has defect	Not constitute a system	Propaganda is not big enough	Leadership role model is not enough
Votes	1561	982	1243	1594
Ratio	92.92 %	58.45 %	73.99 %	94.88 %
Choice	Lack of implementation of cultural	Lack of effective supervision	Punishment is not enough	Lack of effective incentive
Votes	869	1452	1615	567
Ratio	51.67 %	86.43 %	96.13 %	33.75 %

University system on execution of anti-corruption special satisfaction survey there only 9.76 % satisfactory answers among the 1680 valid questionnaires. As Fig. 1 shown below:

In response to the reasons for the system's poor implementation, the select system itself has defect and execution environment is not good enough and the enforcement measures are not strong enough. As Table 1 shown below:

2 Increase the Significance and Role of the College Anti-corruption System Execution

More and more perfect system construction, the legal system is becoming more and growing system of anti-corruption efforts under the new situation, corruption is still repeated, the reason is the lack of strong execution. With the system can not strictly enforce and implement more serious than no system consequences.

2.1 Improve Anti-corruption System Execution Is Important for Discipline Inspection and Supervision

The party constitution clearly stipulates that "the party's commissions for discipline inspection at all levels of the main tasks are: to uphold the Constitution and other regulations of the Party, check the implementation of the Party's line, principles, policies and resolutions, to assist the party's Commission to Strengthen the Construction of organization and coordination of anti-corruption work." education, supervision, check the college party members and cadres to comply with laws and regulations, the party rules of discipline and school rules and regulations, ensure that the provisions of the system can be effectively implemented, in order to promote the healthy and rapid development of various undertakings in schools, colleges and universities important duty of the discipline inspection and supervision departments.

2.2 To Improve the Implementation of the Anti-corruption System Is an Important Starting Point for Combating Corruption in Universities Construction

Corrupt essence is the intentional abuse of power or not. Some people take power as the gain chip, in enrollment, bidding and other aspects of the phenomenon of violation of discipline of every hue. Curb the abuse of power, in addition to strengthen education and punishment, only by strengthening the system construction, by the control system, according to the system work, using the system management rights, in order to perfect the system, regulate the exercise of power. The system can be effectively implemented, about the anti-corruption work success or failure.

2.3 To Improve the Implementation of the Anti-corruption System Is an Important Measure of the Contingent of Cadres

Law-abiding, honest is the basic requirement of cadre. Leader cadre often has more power, more discretion, and is often the makers of the system. Leading cadres must establish system consciousness, the implementation of system, and consciously accept supervision, for the masses to do good. Only in this way, can manage the team, in order to correctly perform their duties.

2.4 Execution to Improve the Anti-corruption System Is an Important Means of Building a Harmonious Campus

The construction of harmonious campus is the rules and humanistic care. Stability and order, work together with one heart, inner and outer Shun, democratic and civilized, honesty, harmonious development is the important symbol of the harmonious campus. The school management work involved a lot of people and people, between people and things should follow the basic rules, the construction of harmonious campus is on aspects of the rules as a guarantee. If there is no perfect system, or the system can't be effectively implemented, the construction of a harmonious campus is an empty talk.

2.5 School Healthy and Rapid Development of Important Initiatives to Improve the Anti-corruption System Execution

Progress of high-level university building, dependent on the level of teachers, teaching standards, research level and the overall level of management depends on top-level design and construction planning, the need to address teaching and research, academic and administrative, hardware and software, school resources and off-campus resources, management and efficiency, democracy and supervision of, the need for impartiality and integrity, hard work, curried, harmonious and smooth political environment, you need commitment to reform, a healthy and active solidarity Director-General of campus culture, etc. These to achieve a sound system to system and powerful system of execution as a guarantee.

3 Perfect the Internal Implement Value of the System

The key factors of execution of system are in the system itself. External causes take effect through the internal ones. No matter how good the executive team and the execution environment is, there won't exist strong executive power, if there is no good system.

3.1 Ensure the Scientific Nature, Applicability and Perform Ability

The internal quality of the system itself is the foundation of the execution. Good anti-corruption system has both principle and operability, both systematic and target, both epochal character and forward-looking (Meng 2008). It has both the carefulness and concise clarity, both stability and the need to revise and so on. Investigate fully and gather the wisdom of the masses, to ensure that the system is advanced and scientific, standardized and reasonable.

3.2 Strengthen the Improvement in Occasion

Guide the spontaneous effect through the reasonable system design and let the executives consciously choose the correct behavior and implementation. It is hard to get the compulsory execution if there isn't matched guarantee mechanism. Notice to lead potential and grasp the hot social concern tightly. The system leads what the general cadre staff can't tolerate and form the situation that executives must implement seriously, then to realize the effective implementation of the system.

3.3 Pay Attention to the People Foremost

The basic attribute of anti-corruption system is to set standard of power operation. But it also needs to maintain the basic rights of people for the value orientation, fully reflecting the people-oriented, respect and inspiration to the people.

3.4 Clarify the Subject of Implement

The system should accurately regulate discretion, clarify the mandate and the subject of the implementation of the system. It should also make the responsible departments and responsibilities aware of what to do, what not to do, how and to what extent, who will supervise, and what should be punished. Non-executive body can be targeted to the implementation of the main implementation of the system to conduct effective supervision.

3.5 Make Use of Technological Factors

Our society has stepped into the information age nowadays, which was particularly prominent in the university. In the implementation feedback, monitoring and other sectors of the system, we should take full advantage of the modern tools and modern methods, and positively make use of the technology to improve the efficiency of the implement of the system (Qian and Geng 2010).

3.6 Keep Pace with the Times

System construction should keep pace with the times. With the change in people's ideas, thinking methods, interest demands, the policy environment, material conditions, system specification content must also change (Liu 2010). Through regular research, opinion polls, the comprehensive information on anti-corruption analysis, excite should take the system performance assessment and evaluation in time to grasp the problems in the system implementation, and modify and improve the system in a timely manner to improve the scientific content of the system and coordination between different systems.

3.7 Build a Institutional System

The anti-corruption system of the University is series of systems which are made under the idea where there is the power, there is the system constraint. It focuses on the teaching, research, finance, infrastructure maintenance, materials and equipment procurement, selection and appointment of cadres, personnel management, recruitment exam, job evaluation, recruitment and other areas and aims at achieving decision-making, implementation and supervision of the mutual restraint and mutual coordination of the system. It should develop plans, make catalogue, and concentrate on legislation, changing, repelling under the unified leadership of party committees of the school, so that both of these systems are extensive, and focused, both independent of each other, and have organic links with each other to form an institutional system with mutual support and mutual restraint (Zang 2011).

4 Enhance the External Execution Environment of the System

The intrinsic quality of the system itself is very important to improve the execution of anti-corruption system. But implementation of the system as the main factors and the implementation of more complex environmental factors, determines the level of execution of the system.

4.1 Strengthen the Public Education of the System Construction

Constitution clearly stipulates that Commission for Discipline Inspection at all levels should always hold discipline education for party members to make decisions on the maintenance of discipline. System awareness of cadres and workers of is an important prerequisite and basis for the construction of anti-corruption. Ideological and political education has been an important way and effective measures to ensure the system implementation (Irani et al. 2004). University party committees should make complying party rules, regulations, institutions as an important part of anti-corruption education, and publicize the anti-corruption system extensively and deep, to enable the cadres and workers making a profound understanding of the spirit, well-known of the content of the system, and growing awareness of the system, firmly establishing the concept of strictly according to the system, developing a habit of implementing the system consciously, changing the system to the conduct and conscious action of cadres and workers. They should also make use of the innovative forms of education and educational resources to maintain effectiveness and long-term nature of the missionary, through documents, meetings, special counseling, training workshops, the theme of education, knowledge contests and other forms, making use of websites, newspaper, blackboard newspaper, radio, fet ion, text messages and other media (Xing and Jia 2011).

4.2 Create a System Implement Cultural Featured by Colleges and Universities

The impact of culture on behavior is subtle, far-reaching and lasting. The Integrity culture is social culture with a respect for honesty and integrity, and removing evils and promoting good. It includes a clean material culture, ideology culture, and also institutional culture. To improve executive power of the system, and ensure the effective long-term implementation of the system, it's important to create a healthy implementation culture of the system, in which all comply with the system, all maintain the system, all worship the glorious system and consciously abide by the system, all feel shameful of going against the system (Zhou 2010). Applying the cultural power to promote the conscious compliance of system of the subject of implementation, the anti-corruption system execution will thereby enhances, improving the anti-corruption level.

4.3 Attention to the Exemplary Role of the Leading Cadres Conscientiously Compliance Regime

Leaders are the fountainhead of their people. If the leaders are uncorrupted then its people are honest. Cadres are examples and models of masses. To create a good school anti-corruption system execution environment and improve the system execution, we have to enhance the education of leading cadres. Help them to establish the ideology of equality before the law and no privileges before the regime. Then they will take the lead in learning, implementation the system strictly and maintain the system consciously and they will fully aware that system is not only a "magic", but also it is an amulet, then set an example in the implementation of the system and infection and drive the cadres and workers abide by the system conscientiously (Hrebiniak 2005).

4.4 Innovative Ways and Means of Implementation of the System

The purpose of colleges and universities anti-corruption system is to regulate the power to curb the incidence of corruption. Therefore, implementation of the system is rigid, does not allow modifications and aliasing. However there are a variety of university system and the implementation of the main situation is very different, This determines the ways and means of implementation of the system should be to be flexible, and timely (Detelin et al. 2005). We need Innovative thinking to break the bottleneck of the system implementation and use the organizational behavior, management, psychology, leadership theory and technological means fully and follow the law of the implementation of the system to achieve the purpose of rigid execution.

5 Establish Mechanisms to Ensure Implementation of the System

The government's execution improving rely on powerful system for protection. Establishing a sound system of the implementation of the evaluation mechanism, control mechanisms, punishment and incentive mechanisms is an important guarantee for the execution's improvement. These will guide, promote and enforce the implementation of the system effectively.

5.1 Establish a System of Evaluation Mechanisms for the Implementation

We should prepare a special council directory, running the school resources for all aspects comprehensively, and organic the appraisal system into the appraisal of cadres annual appraisal system honest government, accountability assessment, office efficiency and democratic performance evaluation, assessment and other work (Hughes 2002). Enhanced system performance evaluation results of the run, this will be appraised as a unit, the first personal assessment, personal promotion and other important reference factor, and increase the system's consciousness and initiative. Place the implementation of the system under the effective supervision of the masses, using effective means to achieve the "Sunshine Review" (Sun 2008).

5.2 Establish Monitoring Mechanisms for Implementation of the System

Power control mechanism's main task is to establish the Independent Commission Against risk assessment early warning prevention mechanisms, procedures and transparent operation mechanism, performance evaluation and accountability mechanisms. These mechanisms are essentially made of the curing system from (Chen 2007). Monitoring the operation of power is essentially to monitor the implementation of the system. Make monitoring the fulfillment of the workflow as the starting point and focus on the implementation of the system, prioritize, grade monitoring, timely stop and correct the non-implementation, implementation software, the phenomenon of chaotic implementation of the system, and promote the effective implementation of the system.

5.3 Establish Mechanisms to Punish Violations of the System

The properties of anti-corruption system itself, determine its constraints and specifications of power. To achieve this purpose, we should establish a sound disciplinary mechanism, severely punish carelessly implementation the system and not timely implementation of the system and the behavior of refusing to implement the system. Determined to correct the command is not executed, and prohibitions of the act By the discipline inspection, supervision, organization, personnel and other departments joined together to form joint conference system for punishment and Integrated use of criticism, disciplinary, economic instruments, the organization processing means to punish violation of the provisions of the system severely in order to ensure the implementation of anti-corruption rigidity execute (Liu 2011).

5.4 Establish a System of Incentives to Perform

Penalties and rewards is the most effective means to improve the execution of the system. Negative incentives is necessary to implementation of the system. However, the model implementation of the system, the staff perform their duties conscientiously, it is essential to the implementation of positive incentives (Bossidy and Charan 2002). We should give recognition and reward for careful implementation of the system and people who play by the rules and effectively improve the system to comply with the political, economic benefits, provide more opportunities for personal development and progress. The demonstration effect will guide cadres and workers consciously compliance system and strictly implementation the system.

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Ownership, Firm Size, CSR Awareness and Charitable Donations of Public Utilities: Evidence from Water Supply Companies in China

Yong-zhong Liao, Yun-feng Wang, and Zhao Zhao

Abstract Corporate social responsibility (CSR) has become a hot topic in academic and in practitioners, and corporate charitable donation is one important component of CSR. The paper studies the influences of three factors on Chinese public utilities' charitable donations by means of 35 water supply companies' information on their official websites during the period of 2008–2011. The empirical results show that only the factor of CSR awareness of a company has positive and significant relations with public utilities' charitable donations. The results suggest the crucial importance of cultivating and constructing CSR culture in public utilities.

Keywords CSR awareness • Charitable donations • Firm size • Ownership • Public utilities

1 Introduction

Over the decades, the concept of corporate social responsibility (CSR) has continued to grow in importance and significance (Carroll and Shabana 2010), and the corporate world is facing the notion of CSR wherever it turns these days (Dahlsrud 2008). Nowadays, CSR has become a hot topic not only in academic but also in practice, and become definitively an important strategic issue (Moura-Leite and Padgett 2011). As a special kind of enterprises, public utilities have a special status, play a crucial role in economy, and are given more expectations by the public (Feng and Xin 2010). Although there are enormous literatures about CSR, the research works of CSR which especially addressed on public utilities seem to be relatively insufficient at present.

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Although there may be many factors which could have impact on the CSR activities of public utilities, but this paper mainly focuses on three factors, which are firm ownership, firm size and CSR awareness, to explore their influences on public utilities' CSR, especially on their charitable donations in the context of China. Are there any actual relationships of these factors with public utilities' charitable donations? And are there any significant different influences of these factors on public utilities' charitable donations? By means of collecting data of public utilities, the paper attempts to answer these questions empirically.

2 Literature and Hypothesis

2.1 Firm Ownership and Corporate Charitable Donations

There are lots of literature regarding to the relations between firm ownership and CSR. Many researchers suggested that firm ownership is one of the important influential factors of CSR activities. Li (2005) argued that the ownership of a firm could have influence on its corporate social responsibility practices and different ownerships generally meant different attitudes towards CSR, and State-owned enterprises founded by the government usually implement its social responsibilities more actively, whereas the private enterprises usually have intense intentions to pursuit the maximization of their profits and undertake their social responsibilities less positively (Li 2005). Xu (2010) also pointed out that firm ownership is one of the crucial determinants of CSR and State-owned enterprises carry out their CSR activities more vigorously (Xu 2010). Chen and Chen (2011) found that there are significant different CSR level between the state-owned enterprises and the private ones, and the state-owned enterprises usually perform better than the latter ones (Chen and Chen 2011). Based on the data of 29 listed companies of Chongqing, Chen and Liu (2011) uncovered that the state-owned enterprises performed much better than the non-state-owned ones when implementing their social responsibilities (Chen and Liu 2011). Therefore, we suppose that:

H1: There is positive and significant relations between the ownership of public utilities and their charitable donation levels.

H2: The State-owned public utilities may perform much better than those of non-state-owned ones significantly.

2.2 Firm Size and Corporate Charitable Donations

There are many studies on the relations between firm size and CSR. Xu (2010) suggested that the firm size is one critical influential factor of executing CSR activities and larger enterprises perform much better than those of small and medium ones (Xu 2010). Li (2005) argued that the firm size may influence the implementation of CSR and large companies tend to undertake their CSR much actively and positively (Li 2005). Huang et al. (2009) found out that there are positive relationships between firm size and their CSR index, and the much larger in size, the much higher level in CSR index (Huang et al. 2009). Tian and Ye (2011) argued that theoretically there is positive relationship between firm size and corporate charitable donations (Tian and Ye 2011), and it is undoubtedly that there is close relationship between the donating amounts of money and firm size (Chen and Wei 2011). Other researchers also uncovered that the larger of a firm, the more money they donated (Haley 1991; Shan et al. 2008). Therefore, we suppose that:

H3: There is positive and significant relations between the firm size of public utilities and their charitable donation levels.
H4: Large public utilities may perform better than those of small and medium ones significantly.

2.3 CSR Awareness and Corporate Charitable Donations

Many scholars have argued that CSR awareness of entrepreneurs and top executives of a company is an important influential factor which plays a critical role in implementing its CSR activities. Wu (2009) argued that all of the respected companies which perform excellently in the field of CSR are those that their leaders have intense CSR awareness and regard CSR as a strategic issue (Wu 2009). Based on an empirical investigation, Bi (2011) pointed out that corporate philanthropy ideology is an important factor which may influence its charitable donation level (Bi 2011). Based on the questionnaire investigation, Jiang (2008) argued that the amount of corporate donations depends on its CSR awareness and does not have close relations with its economic conditions (Jiang 2008). Therefore, we suppose that:

H5: There is positive and significant relations between public utilities' CSR awareness and their charitable donation levels.
H6: Public utilities which have explicit CSR awareness may perform better than those of having implicit CSR awareness significantly.

3 Research Design and Data Collection

3.1 Variable Design

In this paper, we choose one dependent variable (Y: corporate charitable donation level) and three independent variables (X1: firm ownership; X2: firm size; X3: CSR awareness). Here we use Y which represents the donating event numbers during a certain period time to measure the public utilities' charitable donation levels; use X11 represent state-owned ownership, and X12 represent non-state-owned ownership; use X21 represent large size companies whose employees are above 1,000, and X22 represent small and medium size companies whose employees are less than 1,000; use X31 represent explicit CSR awareness whose CSR statements or CSR expressions are clear and definite on their web sites, and X32 represent implicit CSR awareness whose CSR statements or CSR expressions are unclear and indefinite on their web sites.

3.2 Data Collection

We chose water supply companies as the research samples which represented public utilities and collected data from their official web sites. Owing to various reasons, we searched the corporate charitable donation events from January 1st, 2008 to December 31, 2011. About 109 water supply companies were searched and only 35 of them met with the requirements of the research. These 35 companies are located in Beijing (1), Shanghai (3), Chongqing (1), Anhui (1), Fujian (1), Guangdong (2), Guangxi (1), Hainan (1), Henan (2), Heilongjiang (1), Hubei (2), Hunan (1), Jiangsu (2), Jiangxi (1), Liaoning (1), Shandong (1), Sichuan (3), Yunnan (1) and Zhejiang (9).

3.3 Research Method

In this paper, SPSS was used to analyze the data. The data were put into the software and partial correlation analysis and Independent-Sample T test were conducted successively.

4 Results and Discussion

4.1 Results of Partial Correlation Analysis

1. *Firm ownership and corporate social charitable donation level*: In Table 1, $rYX1 = 0.010$, $P = 0.958 > 0.05$. The results show that X1 (firm ownership) has no relations with Y (corporate charitable donation level), and H1 is not supported.
2. *Firm size and corporate social charitable donation* level: In Table 2, $rYX2 = 0.255$, $P = 0.152 > 0.05$. The results show that X2 (firm size) has very

Table 1 Partial correlation coefficients of X1 and Y

Control variable			Y	X1
X2 & X3	Y	Correlation	1.000	0.010
		Significance (2-tailed)	–	0.958
		df	0	31
	X1	Correlation	0.010	1.000
		Significance (2-tailed)	0.958	–
		df	31	0

Table 2 Partial correlation coefficients of X2 and Y

Control variable			Y	X2
X1 & X3	Y	Correlation	1.000	0.255
		Significance (2-tailed)	–	0.152
		df	0	31
	X2	Correlation	0.255	1.000
		Significance (2-tailed)	0.152	–
		df	31	0

Table 3 Partial correlation coefficients of X3 and Y

Control variable			Y	X3
X1 & X2	Y	Correlation	1.000	0.611
		Significance (2-tailed)	–	0.000
		df	0	31
	X3	Correlation	0.611	1.000
		Significance (2-tailed)	0.000	–
		df	31	0

weak and insignificant relations with Y (corporate charitable donation level), and H3 is not supported.

3. *Firm size and corporate social charitable donation level*: In Table 3, $rYX3 = 0.611$, $P = 0.000 < 0.05$. The results show that X3 (CSR awareness) has positive and very significant relations with Y (corporate charitable donation level), and H5 is supported.

4.2 Results of Independent-Sample T Test

1. *The state-owned public utilities and non-state-owned ones*: In Tables 4 and 5, $F_{Y\text{-}X1} = 2.680$, $P = 0.111 > 0.05$, it means equal variances. Mean difference between X11 and X12 is 2.0714, $t = 1.180$, $P = 0.246 > 0.05$, it means that the mean difference has no statistical significance, and H2 is not supported.

Table 4 Results of group statistics

X		N	Mean	Std. deviation	Std. error mean
X1	X11	28	4.2143	4.5088	0.8519
	X12	7	2.1429	1.8645	0.7047
X2	X21	21	4.7143	4.9814	1.0870
	X22	14	2.4286	2.0273	0.5418
X3	X31	12	7.3330	5.3144	1.5341
	X32	23	1.9565	1.5805	0.3296

2. *The large public utilities and the small and medium ones*: In Tables 4 and 5, $F_{Y\text{-}X2} = 4.898$, $P = 0.034 < 0.05$, it means the variances are not equal. Mean difference is 2.2857, $t = 1.882$, $P = 0.070 > 0.05$, it means that the mean difference has no statistical significance, and H4 is not supported.
3. *The public utilities having explicit CSR awareness and those of having implicit CSR awareness ones*: In Tables 4 and 5, $F_{Y\text{-}X3} = 12.573$, $P = 0.001 < 0.05$, it means the variances are not equal. Mean difference is 5.3768, $t = 3.472$, $P = 0.005 < 0.05$, it means that the mean difference has strong statistical significance, and H6 is supported.

5 Conclusion and Implication

There may be many factors which could have impact on the CSR activities of public utilities. The paper specifically focuses on three factors (firm ownership, firm size and CSR awareness of a company) to explore their influence on corporate charitable donations of Chinese public utilities. The empirical findings are below: Firstly, there is no clear relation between firm ownership and corporate charitable donations of public utilities. Secondly, there are very weak positive and insignificant relations between firm size and public utilities' charitable donations. Thirdly, there are positive and very significant relations between CSR awareness of public utilities and their charitable donations. And finally, it is only the factor of CSR awareness that has statistically significant difference of charitable donations. The results show the great importance of cultivating and constructing CSR culture in public utilities.

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Table 5 Results of group statistics

		Levene's test for equality of variances		T-test for equality of means						
									95 % confidence interval of the difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean difference	Std. error difference	Lower	Upper
Y-X1	Equal variances assumed	2.680	0.111	1.180	33	0.246	2.0714	1.7556	−1.5004	5.6432
	Equal variances not assumed			1.874	24.653	0.073	2.0714	1.1056	−0.2073	4.3501
Y-X2	Equal variances assumed	4.898	0.034	1.623	33	0.114	2.2857	1.4082	−0.5793	5.1508
	Equal variances not assumed			1.882	28.469	0.070	2.2857	1.2146	−0.2004	4.7718
Y-X3	Equal variances assumed	12.573	0.001	4.536	33	0.000	5.3768	1.1853	2.9652	7.7884
	Equal variances not assumed			3.427	12.026	0.005	5.3768	1.5691	1.9588	8.7948

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Research on Mechanism of Organizational Culture Infiltrated Based on Shared Mental Models

Guang Xu, Yie-Zhuang Tian, Chen-Guang Zhao, and Xue-Liang Pei

Abstract Organization culture is an important part of enterprise's strategy competitive superiority. It is an important content of organization theory and contemporary management. The formerly organization culture theory has not described clearly so far. To deal with the insufficient of the mechanism of organization culture formed in transform stage, this paper analyses three types of organizational culture infiltrated, and presents infiltration models of organizational culture based on infiltration circle. The analysis on Mechanism of organizational culture infiltrated is combined with shared mental models creatively. Organizing culture is behavior, attitude toward work, mechanics with daily of standard every member of the concept form as soon as kind of intangible strength, it once take form. This paper provides a new research thinking for research of organization study and organization memory study. The paper enrich and perfect contemporary organization theory system.

Keywords Infiltration • Mechanism • Organizational culture • Shared mental models

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1 Introduction

With the tide of global economy development constantly advancing, the development of the word economy has brought a lot of development opportunity to our country's enterprises especially after our county joins into the WTO, at the same time, it also let us see clearly the gap between the world big enterprises and ours. The gap is not only production technology, patent mastered, capital operation and brand-management such hardware index gaps, but internal the organization and deep software index, which is called the gap of organization culture. On which way did organization culture operated is the problem that the organization theory researcher cares for.

Since 1979, after Pettigrew published "Studies on Organization Culture" on Quarterly Management Science (Pettigrew 1979) and Pondy and Mitroff published "Bestride Organization Open Mode" on Studies on Organization behavior the research concept which called cultural model is appeared in organization management field (Pondy and Mitroff 1979). Organization culture becomes mainstream language of organization management and enterprise management affair. In last century 1980s, organization culture has been regarded highly in USA, which has formed a strand of the upsurge studying. These were four works came out at that time drove to study upsurge: Z Theory. Company Culture and Japanese Management Art. Ever since, organization studies field has almost opened a new page, large amount of thesis on theory studies and practical study came forth continuously, and a batch of excellent theory researchers, such as Ouchi, Hofstede, and Schein, have done effective research on organization culture in expert in the field of themselves. Schall (1983) has discussed about organization regulating and the model of organization value passed in his book a kindi of Organization Culture Communicating-Rules Approaches (Schall 1983). Schein (1985) generals organization culture defines By: "Be what the specially appointed group invents, finds that and develops, be used for the form that the basic learning answering the outside environment and integrating a problem's inward assumes, these form operation is fine be enough to have demonstrated effect, as a result, they become the consciousness educating the employee the thinking and feel organize actual problem way" (Schein 1985). In 1986 he divides organization culture being that are three horizontal: (1) surface layer (2) Ying Ran tier (3) reality tier (Schein 1986).

Our country has started from that century eighties medium term, article have announced organization culture right away around authority's magazine in 1986 to the go into organizing culture. After the 1990s are hit by later stage, our country has set off one strands of the upsurge studying organization culture's. Focal point studying aspect, studying in theory is centered on "organizing the culture operation" and "how to constructing out Chinese corporate culture rationality from the Confucian School culture" and so on mainly. Have reached common view such as "organizing culture having improved the organization achievement effect" and "wanting the construction paying attention to organizing culture" mainly; in the field of practice, many enterprise takes important effect irreplaceable by the aspect organizing the culture construction, knowing that culture organizes the force being innovative, boosts enterprise further developing to competition, rise driving the realization organizing a strategic objective, structuring organization core to organization seriously. Culture considers to molding organization as one of the administration means being main. How effective structure builds but the characteristic culture commending the obvious organization characteristic, how to structure the FOAK culture that enterprise suitable develops, how, the inner to spend and the culture spreading organization to wait for the real problem, still is difficult problem facing our country enterprise organization. These problem has also become home and abroad scholars scrambling for studying, has discussed that hot spot. What way organization culture is operated after all with, is to organize the problem that the theory researcher cares for.

2 Concepts Related with Organization Culture

2.1 Organization Culture

Culture is what be gained all abilities and habit in society refer to knowledge, belief, art, morality, law, custom and human being. Organizing culture is an ideal, maximal target, code of conduct, tradition ethos refer to the belief organizing, is value system, fundamental spirit that entire member has commonly among a organization. West scholar Schein gives organization culture to have issued a definition, he thinks: “Organizing culture is specially appointed organize during the period of the problem handling the appropriate outside environment and integrating a variety of appearing in process inward, what invented, found that or developed fundamental hypothesis norm (Schein 1985). This standard operation fine, pretty effective, is used as the way teaching a newcomer observation, the thinking and experiencing rightness about problem therefore”. Organizing culture is behavior, attitude toward work, mechanics with daily of standard every member of the concept form as soon as kind of intangible strength, it once take form, anybody all cannot go against it, only is capable to do otherwise criticizing and punishment bringing in the organization inner to him. Organization culture can precipitate in the quality from every member’s attitude, behavior and entire organization. The norm, managerial control, must be owed organization culture as soon as the individual is subordinate to some organization, accept edifying owing organization mentality culture an atmosphere.

2.2 Shared Mental Models

The main body of a book the key opinion, organizing the culture formation, is to ask formation to share mental models.

The mental model concept is that Craik proposes that from Scotland psychologist Kenneth on 1943 most long ago, he thinks that mentality builds reality composing “the mini pattern”, and make an explanation in being in progress forecasting, ascribing to, and delivering a lecture to the event out to come it (Craik 1943). Since the mentality model concept is brought forward, management science has made no exceptional significance exploration to mentality model definition and structure. Rouse and Morris define mentality model being: And people describes system target and the form, explains the system activity and observes the state to system, forecast system state with the future mechanism (Rouse and Morris 1986).

Cannon-Bowers and Salas start using the concept “sharing the mentality model” formally in 1993, think that sharing the mentality model is to refer to the structure of knowledge that the member of team owns commonly, its feasible member of team can form correct making an explanation and anticipate that to team school assignment, the behavior harmonizing self thereby draws with the school assignment adapting to the Yu team other need of member of team (Cannon-Bowers et al. 1993).

The main body of a book is regarded as sharing the mentality model being a finger: In the team who works, the member, explains the society event and forecasts to come to describe the way with similarity, sharing the mentality model is knowledge and belief that the member of team shares structure, being able to make them take form makes behavior be adjusted to what environment to appropriate making an explanation of work environment and the action forecasting, harmonizing each other, or other member’s call for.

Think that the culture sharing mentality model formation and stabilizing down the queen, organization in the team takes form right away and fixes down process several stages.

3 Organization Culture “Infiltration” Occurrence Mechanism

Lewin organization having had suggested that one contains three steps such as unfreezing, transforming, being frozen again reforms a model, in order to make an explanation and guide how, to arouse, to manage and stabilize organization to reform process, this model has most in joining an organization reforming a model influence (Lewin and Gold 1947). But, Lewin’s this one influence model does not describe that clear organization culture reforms the stage evolution mechanism have most but. And culture forms mechanism theory deficiency specifically for reforming stage organization, three kind pattern of the dyadic “occurrence the main body of a book” is infiltrated bringing forward organization culture, structure puts up the occurrence model infiltrating style owing to that organization culture infiltrates the organization culture “being encircled by”.

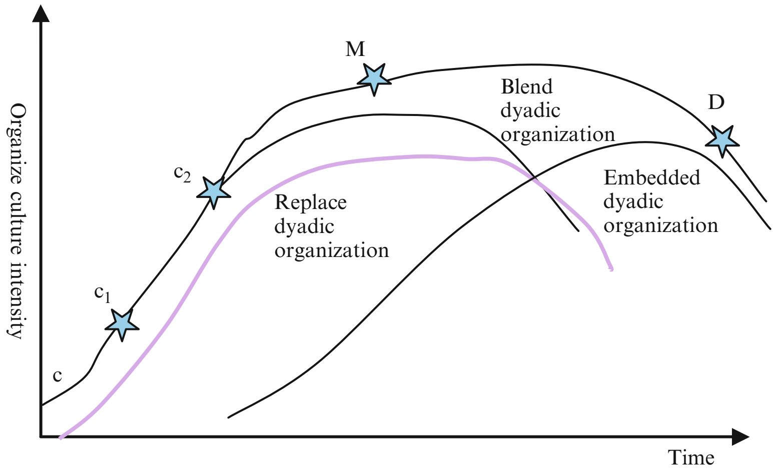

Fig. 1 Anatomising style organizes culture

3.1 Organization Culture Infiltration Happened Pattern

That organization culture comes into being not without ground, is that one urges but accommodates oneself to neither, the structure organizing culture builds the process being that one advances gradually. It has "dyadic development of a infiltration" building build, being maintained and transforming process. Be that alternative way strong or weak is perfect organize cultivating process a period of time and in the process of hereafter ceaseless using, this process needs to be allotted some stage go along, that the correlation degree being unlike a stage, and mutual stage effect degree and their development changes process is the priority studying.

Although the sort process that organization culture structures is briefly identical, since the key elements affecting organization cultural advancement's such as environment, inside personnel been confronted with by characteristic, organization organizing does not build with being unlike organization culture's, should adopt the different pattern. If pursuing what one shows, the main body of a book is reformed with organizing culture's dividing into three kinds patterns, as Fig. 1:

1. Punch, driving force mechanism, evolution pattern and process behavior implanting the interlink age coming to inspect culture dyadic, the secondary in many ways microcosmic main body (mother culture, you culture, this locality culture etc.). Interactive game angle, that culture supplements organization main current mutually than the subculture is parallel, one kind form.
2. Replace, original organization culture cannot be adjusted to environment after growing culture liang meeting each other, the call for changing requires that one kind of new culture carries out the phenomenon replacing thereby. Culture is to take person as carrier this is because, the culture choice is also to chosen by

person, the human being culture having replaced Cheng as a result chooses one of result. The culture replacement also has two kinds manifestation, culture replaces first active, being referring to organizes the original culture replacing self with new culture; Two the culture being passive replaces, this condition sometimes carries the factor having mandatory secretly, is that the member of organization is compelled to accept outside culture. The occurrence sort but resolution that active culture replaces is two premises: Than essential points organizing culture originally, high grade has to many culture once being the other party; That two is the other party's culture is main current culture. Implication passive culture is replaced being as well as having very intense cultural aggression, also being that someone sides pass the various means makes the other party accept self culture, but abandons original culture.

3. Blend, the most common culture in the nowadays appears on meeting under the situation that culture two is a match for to fuse. Fusing what is called is that each other draw lessons, admit, mingle on the basis admitting, taking each other room difference seriously refer to different culture, respect mutually, supplement mutually, is in harmony mutually, process forming new culture's thereby. Culture fuses having three kinds way and approach: Be culture exchange and propagation the first kind. Process is hit by the both sides communicating with in influencing each other, is embodies out self's value and particularity, by the fact that the interactive two-way sum exchanging, changes and perfects oneself. Be that culture adapts to outside culture of sum second kinds localization. Culture adapts to be outside culture and originally with knowledge interactive process. But have culture to Er Yan, catering to fitting in with on self's own initiative being that a kind of has purpose pays with sucking, prepare time and test sometimes because of having large amount of mentality, gain the support on public opinion and concept, effect will be more active as a result, passive fitting in with is that action is not only slow, lags behind, moreover divergent chaos that can produce the inside but, answer effect is not only obvious, the turbulence very easy to arouse thought and society, brings about negative effect. Be revolution of culture type third kinds. That culture transforms is a course of history, it not the simplicity between being that outside culture and capital are with knowledge replaces, but conflict and harmonious between being with knowledge by outside culture and capital put restructuring into practice, produces new model culture thereby. But transform however original culture renewal and evolution, be not to produce one kind of completely independent be different from original culture brand-new culture. That culture transforms is not simple the culture replacing and the unification there being no a difference. Fuse being to resource again combination that organization and the target organize, the process forming a new resource systematically, whose nature is resource restructuring and anatomizing.

In the process of development of organization culture, being not complete abandons original culture, but is an improve and perfect with it's, by one kind of form that original culture and the advanced culture union reach. Be that different type organization culture "infiltrates dyadic" (Infiltration) process studying.

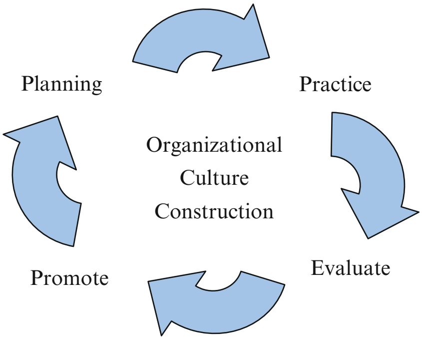

Fig. 2 Organization culture infiltration a "ring"

3.2 *Organization Culture Infiltration Happen Model*

To "the infiltration organizing culture, dyadic" occurrence process, the main body of a book has summarized a model: The infiltration that culture forms "is encircled by" organization, if pursuing what two shows. That model is indicated clearly:

Organizing the culture occurrence process is to assume a cyclic annular period process: plan put the effect planning evaluate organization culture's into practice organize culture being advanced, as Fig. 2.

Organize the culture structure, have one kinds of four arrangement of ideas partition, organize culture soon dividing the arrangement of ideas being matter cultural layer, system cultural layer, spirit cultural layer and synthesizing four cultural layers. The four adecker partition organization culture is infiltrated "being encircled by" a model and being organizing culture looks at and appraises the main body of a book being tied in wedlock, structure puts up organization culture infiltrating style model happened, as Fig. 3.

Organization is confronted with main two challenge generally: (1) outside is adapted to and exists; Integrate in the inside of (2). External fitting in with and survival handle the direction how organization finds such as rightly, the outside environment how to handle ceaseless change's waits for a problem and. Build and keep effective job relation in employee the inside must solve joining an organization as integrating. When thinking that the member of organization has discovered or developed the method handling the outside adapting to and integrating inward a problem's, they have shared knowledge and tentative plan right away, have shared the mentality model in the process that the various function develops gradually in organization culture, having taken form also gradually.

The propagation and irradiation organizing culture need the specially appointed mechanism and carrier. The smooth propagation channel is to organize the key location that culture reforms. New organization culture can be hit by propagation by sharing the mentality model in the employee.

Culture challenges organization for helping organization to answer inside and outside, knowledge and belief to organization middle key event is spread to every member, makes them can share to the information and norm organizing the

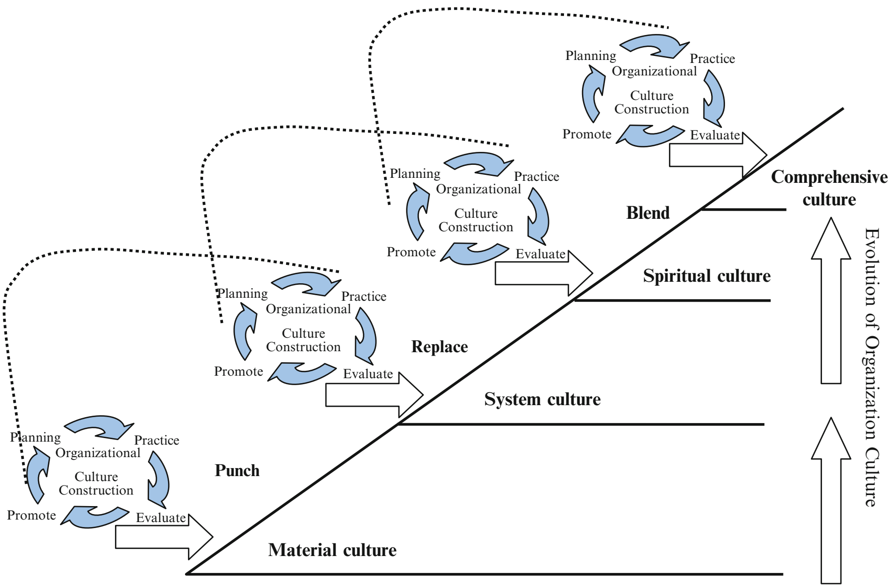

Fig. 3 Mechanism of organizational culture infiltrated

inside and outside environment, organizing aspect such as developing direction and moving relation mutually between the personnel, and with their inner Hua Wei action position and starting point. Organize culture's this has exaggerated sum penetration intensely, has composed to sharing mature mentality model one kind of push strength. Existence is forward between sharing the mentality model and organizing culture relation. Share the mentality model having taken form, imply new organization culture having also taken form.

Idea the way organizing culture to share the mentality model is congealed becoming organization tier culture. In the team who works, the member, explains the society event and forecasts to come to describe the way with similarity, sharing the mentality model is knowledge and belief that the member of team shares structure, can make them take form to making an explanation of work environment suitable and the action forecasting, harmonizing each other, make behavior be adjusted to what environment or other member's call for.

4 Concluding Remark

Organizing culture is behavior, attitude toward work, mechanics with daily of standard every member of the concept form as soon as kind of intangible strength, it once take form. The structure organizing culture builds taking seriously accepting more and more organization. Organization culture set forth by the main body of a book “infiltrates three kind pattern of dyadic” occurrence, process describing that organization culture transforms out comparatively clearly. The occurrence model infiltrating style owing to that organization culture infiltrates the organization culture “being encircled by”, the complete picture having given out organization culture “infiltrating style” happening suggesting that. The introduction sharing the mentality model, the mechanism having described that organization culture “infiltrates dyadic” occurrence microcosmic from microcosmic angle. The “Infiltration organization culture the main body of a book is infiltrated face to face” structures the method go into, will broaden the ken that organization theory and FOAK study, again angle investigation and discussion organization culture occurrence and process developing, have been that the theory organizing the memory studying, organizing studies the go into route having provided the new go into train of thought and may draw lessons at the same time also, have enriched, have perfected and have developed now available organization theory system.

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Use Ideological and Political Work to Enhance the Sense of Social Responsibility of the State-Owned Enterprises

Ju-qin Wang and Bao-lin Li

Abstract The current changes in the domestic and international environments makes Chinese enterprises, especially state-owned enterprises must establish a sense of social responsibility, social responsibility is increasingly becoming an important part of the core competitiveness of enterprises. In China, state-owned enterprises have experienced excessive commitment and escape to social responsibility these two extreme stages. This article is based on illustrate and re-understanding the historical evolution of the social responsibility of the state-owned enterprises, and use the ideological and political work as the starting point to offer a strategic suggestions to enhance the state-owned enterprises' sense of social responsibility. The analysis also takes the people-oriented concept, cultivating a sense of social responsibility of business leaders, improving the incentive mechanism; earnestly implement the scientific concept of development into consideration.

Keywords Ideological and political work • Path • State-owned enterprises • Sense of social responsibility

Research on corporate social responsibility has begun a long time ago. It began in Sheldon (1924). He first linked the responsibility of the business community to its interests (Sheldon 1924). Bowen (1953)'s book *The Social Responsibility of Enterprises* has also described it (Bowen 1953). Carroll (1979) summarized the corporate social responsibility for the economic responsibility, legal responsibility, ethical responsibility, and consciously responsibility (charitable responsibility) four types (Carroll 1979). Frederick, WC thought that corporate social responsibility should not only help companies but also should benefit to society

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(Frederick 1998). With the establishment of China's market economic system and constantly improving, the state-owned enterprises also experienced 30 years of market-oriented reforms, while the basic modern enterprise system had been established, they gradually get rid of inefficient production dilemma and has made a remarkable achievements. In this progress, the guidelines of the ideological and political work of state-owned enterprises had shifted from political objectives to economic construction to serve the actual development needs of the state-owned enterprises. But, behind the success of the success facts, the similar event to "the storage of cotton event" had occurred. Petro China, Sinopec and state-owned corporate image was social questioned, which exposed a series of social problems behind the economic prosperity. Our economy has shifted from "the rapid and healthy development" to "good and fast development," from "giving priority to efficiency with due consideration to fairness" to "pay more attention to social fairness". But the current state-owned enterprises continue the simple pursuit of economic objectives, and ignore the social goals of the practice, which is clearly not in line with the current trend of social development. It ultimately cannot be accept by social public. The current sense of social responsibility of state-owned enterprises is indifferent to a serious imbalance in the economic and social objectives of the situation; there is a need to rethink the state-owned enterprises as an entry point to the ideological and political work. The ideological and political work determines the nature and direction of the development of state-owned enterprises. Therefore, use ideological and political work of state-owned enterprises to enhance the sense of social responsibility of the state-owned enterprises is especially urgent for the sustained and healthy development of the state-owned enterprises or for the construction of a socialist harmonious society.

1 The History of the Evolution of the Social Responsibility of the State-Owned Enterprises

1.1 "Almighty" Stage

Twenty years before the founding of the first arrived reform and opening, China has adopted a highly centralized planned economic system. The resulting state-owned enterprises are often attached to the Government, a subsidiary enterprise closely linked with the government. During this period, the range of the social responsibility of state-owned enterprises is more broadly, in the "all-round" stage, some scholars vividly describe this as "Enterprises running society". On the one hand, in the early days, the state-owned enterprises were responsible for protecting the lifeline of the national economy and consolidated the new people's political power to achieve national economic goals and political objectives of the dual mission; On the other hand, state-owned enterprises subordinate to the government executive order commitment social responsibility that beyond business activities range. Such as social security, enterprise-run school, employee benefits. These social responsibilities assumed by the state-owned enterprises seriously beyond its stage of development, excessive investment and social welfare increase made its own development into serious trouble. “Enterprises running society” weaken the competitiveness and innovative capacity of state-owned enterprises, and eventually led to inefficiencies (Zhang Fang 2009).

1.2 Evade Social Responsibility Stage

In 1978, the Third Plenary Session of the Eleventh Central Committee established a goal which takes economic construction as the center of the reform and development, the reform of state-owned enterprises has also been included in the agenda. However, “the reform of China’s state-owned enterprises” is a reform that does not have an owner and never consider the owner’s rights. The state-owned enterprise workers and the nation’s workers has become the object of reform and bystanders (Liu Yongjie 2002). In the meantime, the planned economic system is gradually breaking down; the role of the market is becoming increasingly prominent. Compared to the state-owned enterprises, some of the non-state-owned enterprises were developed more rapidly. Long subject to the government’s blanket economic running mode, combined with the lack of experience and external system constraints, the state-owned enterprises running short-term economic when it first enter the market and serious damage in varying degrees related to the interests of all parties. Meanwhile, with the establishment of the socialist market economic system in 1992, the reform of state-owned enterprises began to establish a modern enterprise management system. It focuses on the division of functions of government and enterprises, and in particular, to clarify the relationship between corporate social services and government administrative functions. This will undoubtedly inject great vitality to the development of state-owned enterprises, but also easy to make the reform of state-owned enterprises to move towards the extreme one-sided to pursuit economic goals. This will weaken the social security function, the state-owned assets into private pockets. It increased the gap between rich and poor and serious damage to the interests of workers. It appeared the “deprivation privatization” and “centralization” two trends (Zhang Chunmin and Liu Wenji 2007). These phenomena exposed the state-owned enterprises evade the issue of social responsibility to pursuit short-term economic interests.

1.3 The Social Responsibility Regression Stage

Since China’s accession to the WTO in 2001, its direct impact is the development of China’s increasingly integrated into the world tide; the Chinese market has become an important component part of the world market. As Chinese companies continue to go out of the country as well as a large number of foreign-funded enterprises seize the Chinese market, Chinese enterprises' operating model which take maximize profits for the target lead to increasingly significant negative issues. For example, issues such as environmental pollution, product quality, workers rights and interests become the focus of the whole society in general. This shows that the self-perception and social expectations of the social responsibility of the state-owned enterprises has been contradictory (Liu Ling 2007). Emphasis on economic efficiency and neglect or even ignore the practice of social responsibility has become obsolete. Therefore, the social responsibility should be back to the actual development of state-owned enterprises. On the one hand, the state-owned enterprises need to play an exemplary role to bear the social responsibility, which is determined by the nature of the state-owned enterprises. On the other hand, it should insist on a combination of economic objectives and social responsibility—The economic goal is international competitive advantage, social responsibility is to solve social problems, the combination of the two is the correct choice. State-owned enterprises is a lack of social responsibility, we should focus on solving the problem that enhance the sense of social responsibility of the state-owned enterprises, in order not to further intensification of social contradictions.

2 Further Understanding of the State-Owned Corporate' S Social Responsibility

The social responsibility of state-owned enterprises experienced a re-return phase, which is the process we have a constant awareness of the social responsibility of the state-owned enterprises. Therefore, we should re-understand the social responsibility of state-owned enterprises combined with the current social environment. It is the basis and prerequisite for state-owned enterprises to effectively fulfill their social responsibilities in the future.

2.1 A Further Understanding of State-Owned Enterprises Based on the Nature

As a tool and means of government involvement and intervention in the economy, state-owned enterprises play a different role in the market system of different maturity. Under the socialist market economic system, in particular, China is in the exploratory phase of the combination of socialism and the market economy, China's state-owned enterprises is not only a means of government intervention in the economy, while still a means of participation in the economy. On the one hand, it is different from the general corporate, general corporate social responsibility is derived in the process of pursuing economic goals. The economic goals of the state-owned enterprises are to fulfill their social responsibility services. On the other hand, the social responsibility of the state-owned enterprises is not equivalent to "Enterprises running society", it also need the rational pursuit of economic efficiency, Especially in underdeveloped productive forces in China's case, the state-owned enterprises still cannot completely withdraw from the competitive field. This still has an important role for the improvement of the market economy system, regulating income distribution and maintaining market order. In short, the current state-owned corporate social responsibility go hand in hand with economic goals, the key is that the economic goals of the state-owned enterprises is to achieve its social responsibility and service.

2.2 A Further Understanding of State-Owned Enterprises Based on the Goals

In real life, we often see the economic goals of the state-owned enterprises and non-economic goals always coexist, it is difficult to have a clearly defined the boundaries. "State-owned" property specifies the state-owned enterprises should be to achieve the interests of the people, "not economic" seems to be a proper meaning. "This 'not economic' means in a measurement period, the state-owned enterprises in countries using a certain amount of credit, capital, talent and other social resources, but cannot match economic gains and the market value of these resources" (Huang Sujian and Yu Jing 2006). It shows that as a special case of the general business, state-owned enterprises is the same with general corporate in pursuit of common economic goals. But its particularity is that the state-owned enterprises achieve the economic goals on the basis of non-economic goals. Therefore, the state-owned enterprises can only achieve economic goals by fulfill their social responsibility. The pursuit of economic efficiency of state-owned enterprises is in order to serve a better service for the people and the general public within a longer period of time.

3 Us the Ideological and Political Work to Interpretation the Path of the State-Owned Enterprises to Achieve Their Social Responsibility

In 2008, the SASAC issued guidance of central enterprises to fulfill their social responsibility. It pointed out that the central state-owned enterprises should enhance the sense of social responsibility, and actively fulfill their social responsibilities (Guidance on the central enterprises to fulfill their social responsibility 2008). Recently, guidance by nine ministries and commissions of the National

Development and Reform Commission, the Ministry of Industry, the Ministry of Civil Affairs, the State Council, the SASAC, sponsored by the China Federation of Industrial Economics *2012 China's Industrial Economy, Industries and Enterprises Social Responsibility Report press Conference* was held in Beijing. State Grid, China Sinopec, Baosteel Group, 74 companies have a social responsibility report released at the conference (Corporate Social Responsibility Report of China's industrial economic sectors conference 2012). This invariably shows that China's business environment has increased the pressure on state-owned enterprises to fulfill their social responsibility. It has become a new driving force for business innovation and development. For this reason, many scholars state-owned enterprises should improve the social responsibility information disclosure theory (Dai Benjiao and Jin Yifang 2012) to build a state-owned corporate social responsibility evaluation index system (Liu Shuhua et al. 2011), to circumvent the lack of responsibility of state-owned enterprises ecological ethics from the perspective of ecological ethics (Cheng Xiubo and Zhang Jinjin 2012), in order to Law angle norms of social responsibility of the state-owned enterprises (Jian Jizhi 2006) published a CSR report and other external aspects to promote the state-owned enterprises to fulfill their social responsibility. But the materialist dialectics told us that external factors can play a role only by internal factors. Under the new situation, the ideological and political work should escort the reform and the harmonious development of state-owned enterprises. Specifically:

3.1 Integration into the People-Oriented Philosophy

Man is a core factor in the survival and development of state-owned enterprises, but also the cornerstone of the ideological and political work. People are the main body and the stakeholders of the social responsibility of the state-owned enterprises. Therefore, the ideological and political work should integrate into the concept of people-oriented and focused on the interests of all the people. To give full play to the characteristics of the implicit education of ideological and political work, as a carrier in the building of enterprise culture, and gradually implant people-centered core into the values of state-owned enterprises in order to promote the culture of social responsibility awareness. In the enterprise, we should earnestly safeguard the legitimate rights and interests of workers in the attitude of the staff caring and responsibility. Processing reform the relationship between the outflow and inflow of workers, the workers must not be blind to the society to its own devices. Enterprises to rationalize their own relations with the people must have a clear business ownership in the hands of the people. Therefore, the final development of state-owned enterprises is to the benefit of the people.

3.2 Cultivate Sense of Social Responsibility of Business Leaders

As the saying goes: "train runs fast, depends on the front belt." Famous Chinese entrepreneur Zhang Ruimin, who describes his own Haier in the role, said: "The first designer to adapt to the development of enterprises in the organizational structure of enterprise development manipulation." He added: "What I fear most is that the staff of the entire enterprise believed me too much. If I chose the wrong path, jump into the pit of fire, then the entire enterprise will also follow me jump into the pit of fire." Obviously, business leaders have an important position in the enterprise development. Therefore, in the day-to-day ideological and political work of state-owned enterprises, we should continue to focus on training the awareness of the social responsibility of the leadership by training workshops, seminars, field trips, etc. And we should root the sense of social responsibility in the ideas of leadership. Secondly, the leader of the state-owned enterprises should enhance awareness of social responsibility to the enterprise spirit of enterprise. It grows gradually in the production and management (Yang Yuekun 2011). Haier, for example, take the "dedication and pursuit of excellence" as its spirit of enterprise. The leader of the state-owned enterprises should concise their social responsibility into brief discourse. Finally, the leader of the state-owned enterprises should also use specific ways through a variety of ideological and political work to turn the social responsibility of conviction into the conscious pursuit of the workers. And further enhance the overall awareness of corporate social responsibility. Of course, as the classic problem: Who monitors the monitor (Alchian and Demsetz 1972)? business leaders should be given high priority. After all, "the more people that can introduce a different tone, the more you can make the song sounds wonderful (Radbruch 1997)."

3.3 Improve the Incentive Mechanism

We call on the state-owned enterprises to take on more social responsibility, but not the same as in "Enterprises running society". State-owned enterprises still have the economic side. At the same time, the state-owned corporate social responsibility to fulfill in the pursuit of economic goals to achieve. Therefore, from a macro perspective, it is not blindly through corporate earnings and to determine how much of its social responsibility to the degree of fulfillment, but to see its actual contribution to the community size. In this regard, the need for ideological and political work should give daily positive publicity and timely diversion. This is the premise to implement the right incentives. In the micro level, when the actual behavior of the workers within the state-owned enterprises do help to the enterprises to fulfill their social responsibilities, material means and spiritual means of ideological and political work must be combined to form an effective incentive for employees. To increase in line with the possibility of corporate social responsibility behavior recurring. And gradually let the workers to agree that companies should bear the social responsibility. On the one hand, it helps to improve the consciousness of workers to fulfill corporate social responsibility; On the other hand, it can also contribute to the formation of benign oversight atmosphere within the enterprise. This benign “bandwagon effect”, spread to the countries between enterprises, formed in the society as a whole range of “corporate reputation pulling mechanism. By reputable market excess reward to an invisible, active incentives prompted state-owned enterprises to enhance their competitiveness at the same time actively fulfill their social responsibilities (Zhang Yanan 2011).

3.4 Earnestly Implement the Scientific Concept of Development

Some scholars believe that the social expectations of the different stages of social development of public enterprises are different about the concept of corporate social responsibility model. It needs business from the “economic man” in a timely manner to the “social” transformation. Use enterprise development to promote social harmony (Wan Li and Luo Yifen 2006). State-owned enterprises are no exception. Thus, to establish the scientific concept of development, walk the road of sustainable development is an important content of the state-owned enterprises to fulfill their social responsibility. This is the need to achieve the harmonious development of man and nature, and also get out resource shortages, environmental degradation pose a serious constraint on economic development of a realistic way. For this reason, in the ideological and political work of state-owned enterprises should actively publicize the implementation of the national scientific development decision. Establish a feedback mechanism to ensure that state-owned enterprises to take the road of sustainable development. Develop the recycling economy, protect the ecological environment, established a low resources consumption, little environmental pollution and sustainable development model as soon as possible. State-owned enterprises through fulfill the social responsibility. On the one hand, good social benefits to the firm to fulfill social responsibility beliefs. And get good social benefits to firm the beliefs to fulfill social responsibility beliefs. On the other hand, it can radiation related businesses. Drive all the social enterprises to fulfill their social responsibilities. It will lay a solid foundation for the rapid development of enterprises.

3.5 Scientific Construction of the State-Owned Corporate’s Social Responsibility Model

Social responsibility of state-owned enterprises is a very vague definition. The confusion of enterprise internal responsibilities, rights and interests is an important reason for the current lack of social responsibility of the state-owned enterprises.

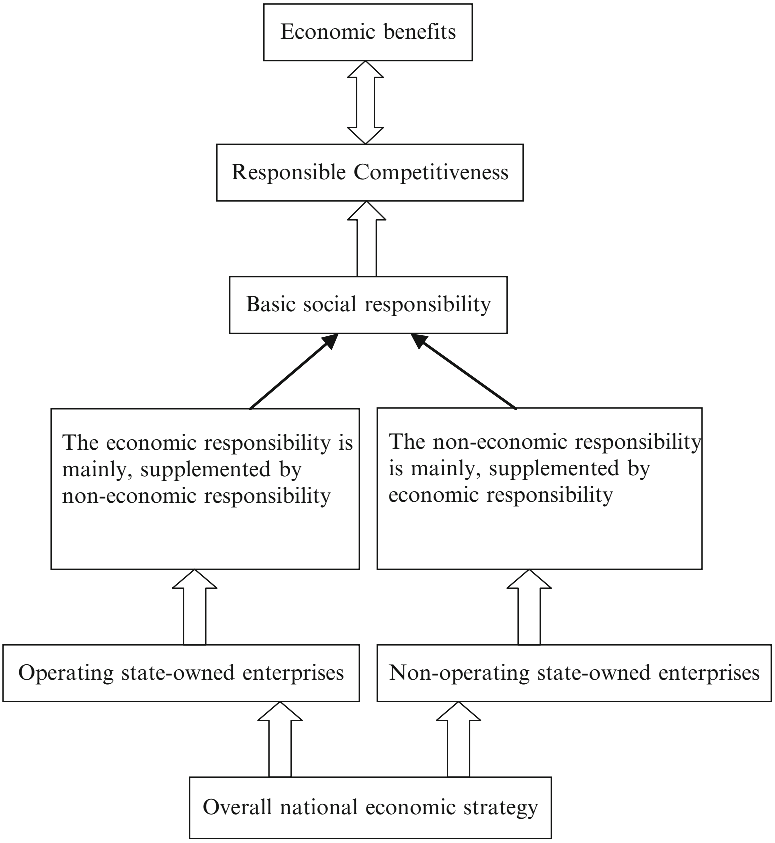

Fig. 1 The state-owned enterprise social responsibility model

As the saying goes, "no rules no standards." Scientific and rational model of social responsibility is a basic blueprint for state-owned enterprises to take positive steps to social responsibility. Therefore, the ideological and political workers of state-owned enterprises should have a grasp on the basis of the national economy overall strategic objectives and state-owned enterprises reform direction, combined with the resources and positioning of the enterprise, then proposed the social responsibility requirements. In the process of building the model, you should follow the principle. The specific requirements are level by level, step by step. Combine of theory and practice, individual and general. Take Fig. 1 for example, the state-owned enterprises is roughly divided into two types of operating and non-operating. The social responsibility they burdened adjusts according to the different periods of the country's economic strategy. In addition, except to have the same basic social responsibility, they should also accept their share of special social responsibility. Economic responsibility and the non-economic responsibility are difficult to distinguish. Therefore, the companies tend to take some responsibility, supplemented by other. In particular, no matter what kind of social responsibility it is. It conducive to constitute the responsibility of competitiveness of enterprises. "Encourage enterprises use their professional advantage to solve the social, environmental, and employee problems. Enable enterprises to fulfill their social responsibilities while the economic benefits improved and corporate responsibility competitiveness enhanced (Yin Gefei 2011)."

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Part XI
Management Sciences – Stratagem Management

Series Brand Building Modes of Liquor SMEs—A Case Study of Yanghe Spirit

Jin-ting Lu

Abstract Based on sound market research, Spirit was created by Yanghe in 2003. Its brand building experienced long-time excellent planning, scientific product reasoning, accurate brand positioning, as well as proper marketing. After 10 years' development, Spirit has already grown into a remarkable brand leader in modern liquor industry. Its great brand branding and marketing activities brought us "Blue storms" one by one; and its success was recognized as "Yanghe Mode". In a word, Spirit's outstanding branding strategy made it stand out of so many competitors, its brand building modes are valuable for liquor SMEs.

Keywords Brand core value abstracting mode • Brand building mode • Spirit • Series brand building mode • SMEs

1 Introduction

Yanghe, a famous liquor brand once listed in Chinese eight-old-famous before 1990. However, it kept going down since then. Although it was still famous around Jiangsu province, and consumers had profound emotional affection for it, the fact that Yanghe became a cheap liquor brand was beyond doubt. Survey showed that when mentioned Yanghe, consumer would first came up with two cheap liquor products of Yanghe: Blue Porcelain Decanter and Flying Apsaras.

There are lots of cultural and emotional reasons for people to consume liquor, but the typical dazzled impression of drinking liquor is a huge challenge in marketing liquor products, especially in the context of profit declining in mid-end and low-end liquor market. Then high-end market becomes a scramble for enterprises.

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Under this background, Yanghe had to adjust itself to fit new environment to get development space. And the creation of its high-end brand—Yanghe Spirit helped Yanghe became a leader in the high-end liquor market during the following years. The modes of Spirit's brand building worth studying.

2 Brand Building Process (1999–2003)

2.1 Background of Yanghe Spirit Building

1. *Yanghe's brand structure was incomplete*. Figure 1 shows several famous liquor brands and their prices in 1995. Obviously, Yanghe's lack of products above ¥200 directly led to no competitive edge in high-end liquor market. At the same time, Moutai, Wuliangye, Jiannanchun already had built relatively perfect brand structure, they had high-end market' price lines covered by several high-end sub-brands. Under this circumstance, if Yanghe still hadn't taken any action, it would be outdistanced forever by competitors. So, the most urgent thing for Yanghe was to create high-end brand as soon as possible.

   In order to cover high-end liquor market in a short time, Yanghe decided to build a series brand instead of developing a single brand with only one product, which insured that Yanghe can cover the high-end market in a relatively short time. That's why Spirit was created with three price level products.

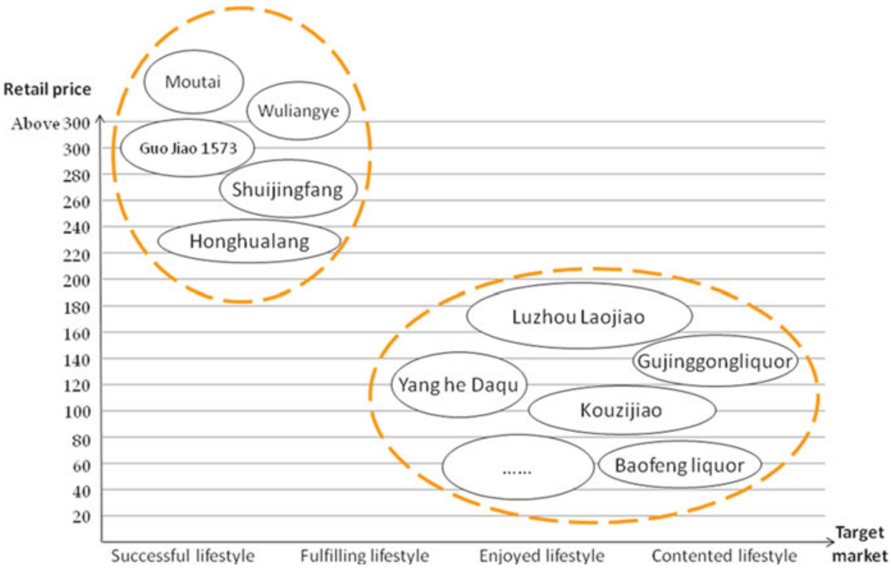

Fig. 1 Liquor brands distribution diagram in 1995

2. *Consumer's new needs and wants.* When an enterprise is challenged, they should firstly do study on market. Since 1999, Yanghe conducted its market research to get to know the real thoughts of consumers. They selected 2,315 samples to test their new liquor, used SPSS to analyze the relations among those tested factors. Yanghe found that the crying need of consumers was to develop products of "low, less filling with long aftertaste, very comfortable after drinking". This information was essential for Yanghe to develop high-end products with improved taste.

   In 2003, based on earlier profound market research, Yanghe finally invented new liquor craft. On 26th Oct, 2003, Yanghe's new craft was affirmed by Science and Technology Department of Jiangsu Province, and the master work of this craft is Spirit.

3. *The nationalized goal was Yanghe's development power.* With intense competitive situation, all the high-end liquor products are of nationalized brands; regional brands usually occupy mid-end and low-end markets. Thus, high-end oriented and nationalized became the core development strategy for Yanghe. To achieve success, Yanghe must merit nationalized brands' building experience and brand building strategy.

   Generally, there are two typical modes for nationalized liquor corporations to build their high-end brand building.

   Traditional High-end brands usually have strong brand images, like Moutai, Wuliangye who drive their high-end market with existing brand power.

   Emerging high-end brands like Shuijingfang and Guojiao 1573 achieved success in a way of building their high-end brand images through separating them from their old mother brands.

   Although Yanghe was well known by people, most of its products were mid-end and low-ends, so if Yanghe hoped to successfully build a high-end brand, it should also separate the new brand from its old mother brand—Yanghe, so that to weaken the old mother brand's low-end and negative impressions of people.

2.2 Process of Spirit's Brand Positioning and Core Value Abstracting

The American Marketing Association defines a **brand** as "a name, term, sign, symbol, or design, or a combination of them, intended to identify the goods or services of one seller or group of sellers and to differentiate them from those of competitors" (Keller Kotler 2002). So in order to make a brand different from competitors', the first important thing is to do brand positioning. Positioning is to put a permanent mark on its style in order to be different from the competitors' brands (Ding and Tang 2007). We should note that positioning is not what enterprises can do, but what they can do to their target audience.

1. *Positioning creates brand differentiation*. While doing branding, positioning creates a unique image in customer minds that reflects what they think and feel about a product—how they value it. And positioning will give a brand its personality—the idea that a product takes on familiar human characteristics, such as friendliness, trustworthiness, or snobbery—is an important part of an brand image (Wells et al. 2005).
2. *Positioning is an essential competitive edge.* Constant deepening of economic globalization and increasingly fierce of market competitions directly lead to liquor products' homogenization. Strong brands' competitive edge comes from their unique brand positioning (Huang 2010). In a word, a successful brand building firstly goes with proper brand positioning.

Spirit's brand positioning followed three steps:

1. *Make out the target market*. Combined with market research data, Spirit's target market aged 30–45, who are the elites of society and the leaders of social trends. Those people have stronger purchasing power and consuming needs; they buy products matching their social class and status; they always have a favor for high-end brands. Thus, Spirit had the potential to be consumed.
2. *Fulfill target consumers' needs and wants.* Generally, people buy products for certain reasons, either for functional interest or emotional interest (Solomon 2007). Excellent brands should enable themselves fully considering those two concerns of consumers.

   Rational value in fact is the real function of products, When consumers buy liquor, they firstly considered the usages of it (e.g. the degree of the liquor, how it feels? Is the price reasonable? Is the quality good?), all of which help customers judge whether to buy the product or not.

   Emotional value is the psychological dimensions of one brand. The psychological side includes the emotions, beliefs, values, and personalities that people ascribe to the product (Wells et al. 2005). People consume liquor to show and express themselves. Thus, consumers choose liquor brand out of emotional reasons. Spirit identified its consumers' honor needs and wants, as shown in Table 1.
3. *Perfect high-end products are needed.* After identifying target consumers, brands should provide appropriate products for them. In terms of their high-end target consumers' honor needs, Spirit should provide high price and high quality products for them.
4. *Spirit's brand positioning and core value.* On the aspect of brand positioning, Spirit highlighted its products' new after-drink soft continuous feeling while keeping traditional taste, odor type. Besides, blue, the main brand color of Spirit, represents wisdom, modest, modern civilization, science and technology, the world, the future and so on. On the basis of product analysis and the deep understanding of consumer needs and wants, Spirit' s brand image was coming out—A broad-minded man who can roll with the punches and handle in all situations, pursuing their dreams consistently.

Table 1 Liquor consumers' different consuming needs and wants

Consumption patterns		Motives	Consumers' core needs and wants	Brands' core value	Symbolic brands
Gift giving consuming		Emotional link/PR	Dignity/ psycho-logical demands	Honor/dignity	Moutai
Drinking together	Business/ political	Hold and control the scene/PR ability	Show the sincerity	Dignity/status	Wuliangye/ Jiang-nanchun/ Guo-jiao1573
	Party drinking	Communication with friends and closer relationship	Show passion/ admira-tion/glory	High quality life	Shuijingfang

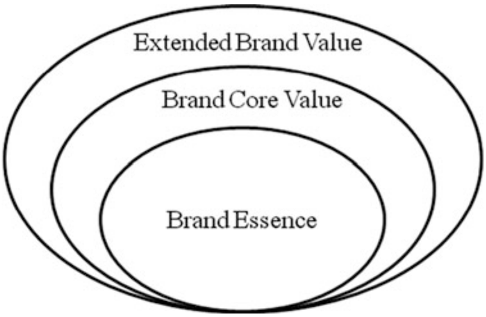

Fig. 2 Aaker's brand identity mode

2.3 Brand Identity and Design

After brand's position, Yanghe kept going on to create Spirit's brand identity, which is a link with target audience. Effective communication needs explicit brand identity, so that to be identified by consumers and cannot be easily forgotten.

Once Yanghe's overlooking its brand building directly resulted in no strong brand image and no competitiveness. Since Yanghe determined to build Spirit as its high-end brand, it made explicit brand building plan supported by series brand building activities proved to be a success; partly accounted for its success is its brand identity can be interpreted by David Aaker's brand identity mode (Fig. 2) (Xiao 2002).

Aaker's brand identity mode contains brand core value, extended identity and the soul of brand. A successful brand identity should include all those three parts and reflect values of enterprise, so that consumers can have the same feeling the brand means to deliver. Of course, brand's core value identity is the most important part of the brand identity mode, and Spirit' brand identity can be resolved as shown in Table 2. We will discuss the brand core value abstracting mode later in this article.

Table 2 Spirit's brand identity analysis

Brand identity elements	Contents	
	Visualization	Strategy
Brand core value	▼	—Wisdom, broad-minded
Brand value	▼▼	—Product quality: the best products —Product connotation: pursuing dream
Extended brand value	▼▼▼	—Traditional: special style of sweet, soft, pure, aroma —Characteristic: fashion sense、wisdom and rationality
Slogan	▼▼▼	Men's feelings

Fig. 3 Logo of spirit

洋河藍色經典

——男人的情怀

1. *Features of Spirit's brand identity.* Combining with traditional culture and historical elements, Spirit's brand identity has its own specific features.

Firstly, the success of Spirit's brand building perfectly realized Yanghe's long-term development strategy. Wuliangye exceeded Yanghe in 5 years time (from 1991 to 1996). Since 1996, Yanghe began to fall further behind its once close competitors. Since 1999, Yanghe determined to catch up with and surpass Wuliangye in another 5 years' time. The urgent challenge was to implement scientific brand strategy. Only in this way, can Yanghe regenerate from its declining. Spirit arose at the historic moment; its brand identity is the key to realize the goal.

Secondly, having dream and making progress are the original dynamic of our nation. As a spiritual symbol, Spirit has the responsibility to make our national dream come true.

Thirdly, Spirit's brand identity is really recognizable. Almost all high-end brands' core values are related to Chinese traditional culture and social values, besides of which Spirit has more of Chinese inner needs and characteristics. It is easily recognizable for people.

2. *Design of Spirit brand identity.* After analyzing Spirit's brand identity, its brand visual identity design is on the tip of the tongue. See the core part of Spirit's brand design, its logo as shown in Fig. 3.

   The features of Spirit brand's identity are: firstly, the Logo is composed of three parts: brand name, brand appeal, and names of its series products; secondly, liquor industry has no series brand before; thirdly, the color of Spirit's brand identity is distinguished from other high-end brands; fourthly, the logo is combined with brand slogan, which is really useful for brand communication.

3 Brand Communication Process (2003–2009)

After brand positioning and identifying, Spirit conducted its communication strategy. In terms of brand communication, Yanghe made a long-term planning:

The 1st step: Quickly create brand awareness and reputation in Jiangsu province; build a sound basis for further brand development.

The 2nd step: Implement regional strategy, farther improve the brand's awareness and reputation, cultivate loyal consumers, and build a stronger brand basis for nationalized development.

The 3rd step: Implement nationalized strategy, to be top 3 high-end liquor brands.

3.1 Perfect Advertising Creative and Expression

The strong guide function of advertising makes it the most effective communication tool in modern times. Thus, Spirit's brand communication strategy took advertising as the main means to communicate with its target audience.

In terms of advertising creative and expression, corporation resources, consumers, channels, competition situation should all be included.

As for advertising slogan, Spirit's brand communication got rid of stereotyped cultural elements, combined with its former brand positioning—a broad-minded man, so Spirit's advertising slogan was "Man's feelings", which properly described its brand core value.

3.2 Effective Traditional Media Strategy

Effective brand communication needs scientific media planning and proper communication tools, which can help brand, build sound relationship with its target audience (Liu 2008). In this way, the first important thing for Spirit is to make sound media strategy.

Traditional mass media still plays an important role in our life; almost all the high-end brands are doing commercials on TV, radio, newspapers (Xiao 2002). In this case, to better communicate Spirit's brand image, Spirit chose mass media to be the focus media.

As every communication tool has shortcomings. Spirit made use of different communication tools in different brand building stages. In the first stage, Spirit chose traditional advertising as the main tool to create brand awareness. In the second phase, Spirit continued doing traditional advertising to create much more brand awareness at the same time made use of event marketing to improve brand's social influence. Later facts proved that the media strategy of Spirit was very effective.

3.3 Ingenious Event Marketing Strategy

Since Spirit was created in 2003, its high-end brand image was quickly built through effective marketing strategy. In 2008, Spirit's sales volume reached to 268.2 billion RMB in only 5 years' development. Yanghe became the leader of Jiangsu liquor industry. Most important key to its success is its event marketing strategy.

In 2008, the 27th Olympic Game was held in Beijing, Yanghe made great use of it with a slogan "Come on, China". In 2009, Yanghe took actions to do brand marketing during the 60th birthday of PRC with an amazing slogan "Sea sky dream, China power", in which not only included the names of Spirit's series products, it also contained the best wishes to our country. The most brilliant of the slogan was that it hinted Spirit's following brand fission and upgrade.

4 Brand Fission and Upgrade (2010–2013)

When Spirit' brand equity was over 100 billion, owning thousands of loyal consumers, the connotation and mission of the brand need to upgrade.

4.1 Brand Fission: Get Ready for Brand Upgrade

Spirit had three series products of Sea Blue, Sky Blue, and Dream Blue. The process of Spirit brand fission began with its products fission following three steps:

Firstly, developed three products under Sea Blue, Sky Blue, and Dream Blue separately;
Secondly, built Sea Blue, Sky Blue, and Dream Blue as three new independent sub-brands;
Thirdly, conduct sound price strategy to cover huger high-end market to strengthen Yanghe's competitiveness.

At the same time, the brand logo of Spirit was also adjusted accordingly. See Fig. 4.

Fig. 4 New series brand logo

In 2010, Spirit successfully realized its brand fission; Sea Blue, Sky Blue and Dream Blue got upgraded and became three new high-end and mid-end sub-brands of Yang he, hereinto, Dream Blue became a luxury brand stands for its corporate image. Now Dream Blue's new brand positioning is "Dream China, Dream Blue", which is perfectly linked with our national dream.

4.2 Brand Upgrade: From Man's Feelings to National Dream

In 2010, Yanghe built Su liquor group with Shuanggou, another famous regional liquor brand; in 2011, by use of double-brand strategy, Yanghe devoted itself to build Chinese largest liquor city to revive Jiangsu liquor industry; at the end of 2012, with our national President Xi's speech on Chinese Dream, Dream Blue's Dream is closely linked with our national Dream. In 2013, with a slogan "Dream China, Dream Blue", Dream Blue sponsored "2013 CCTV Spring Festival Gata", and Yanghe's nationalized dream eventually came true.

5 Conclusion

After analyzing Spirit's branding process, we find that brand positioning, brand communication, and series brand building are core strategies to Spirit's success. There are three modes abstracted from Spirit's branding for SMEs to build strong brands.

5.1 Brand Core Value Abstracting Mode

Brand core value abstracting mode (Fig. 5) includes three aspects: competitor analysis, consumer analysis and brand analysis. Competitor analysis means that

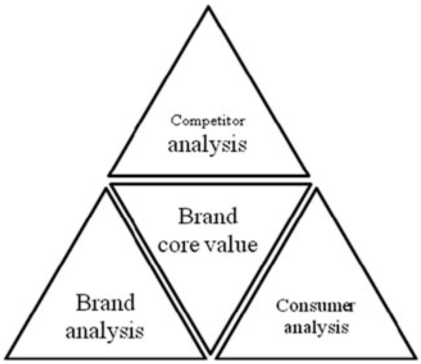

Fig. 5 Mode of brand core value abstracting

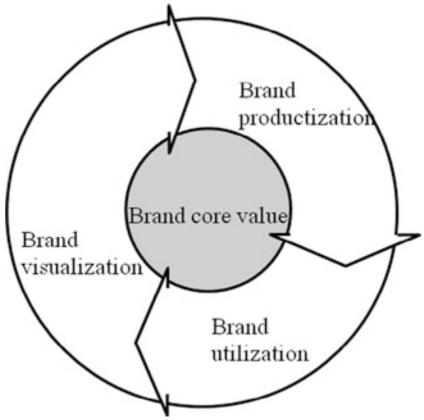

Fig. 6 Mode of brand building

brand's core value must be different from competitors' and easily recognized by consumers; consumer analysis is to explore consumer needs and wants; brand analysis is to examine brand itself so that to meet consumers' needs and wants.

All brands' core value abstracting should contain those three aspects so that to make a proper brand positioning.

5.2 *Brand Building Mode*

After brand core value abstracting, then we go with the brand building mode including three levels, see Fig. 6.

The first level is Brand productization, which is to improve brand's reliability by products that meet consumer needs and wants; the second level is Brand utilization, which is used to help consumers understand the use of products and encourage them to buy them; the third level is Brand visualization, the last and most important step to build brand image.

These steps are basic thoughts and methods for SMEs' brands building.

5.3 *Series Brand Building Mode Based on Life Cycle Theory*

In the end, the paper wants to share series brand building mode under the situation that mother brand image is not strong enough to support its sub-brands (see Fig. 7). When series brand is in its introduction period, creating brand awareness is the first important event; when series brand is familiar to its target consumers, we should work hard on leveraging users to become brand advocates and engender brand loyalty so that to build strong basis for brand fission, Once series brand goes into the saturation period, upgrading brand should be put more emphasis on. We should

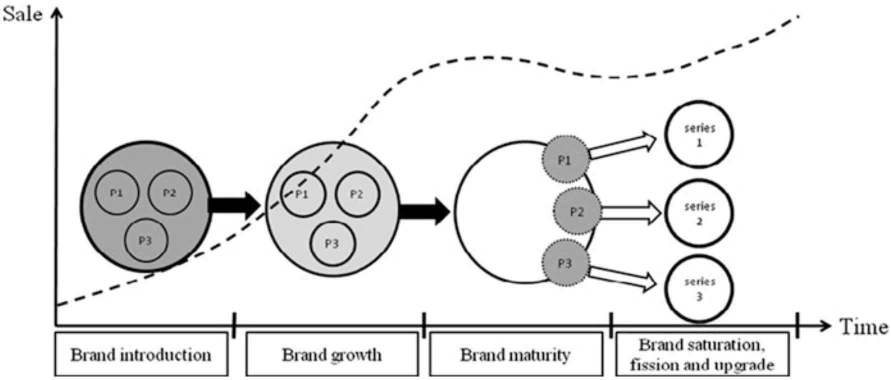

Fig. 7 Mode of series brand building

keep in mind that series brand should adjust its brand building strategy to adapt to different situations during its life cycle.

Building a strong brand is both an art and a science. It requires careful planning, a deep long-term commitment, and creatively designed and executed marketing. A strong brand commands intense consumer loyalty—at its heart is a great product or service (Keller Kotler 2002).

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Research on Value Activities Optimization Management of High and New Technology Enterprise Based on Core Competence

Jian-long Wu, Hong-qi Wang, and Li Tian

Abstract The nature of existence of the enterprise lies in sustainable value creation, and it is the key to quickly develop comprehensive advantage of the high and new technology enterprise that optimizes internal and external value activities around core competence. After characteristics analysis and classification of value activities of the high and new technology enterprise, the paper designs optimization standard and layout ideas of internal value activities, and puts forward key factors on optimal selection of typical collaborative approaches of external value activities, based on unique feature and level of core competence. Then, it discusses "refocusing" and reengineering emphasis and upgrade paths respectively corresponding to promotion and reconfiguration process of the core competence. In short, the study aims to offer theoretical guidance for dynamic management of value activities of the high and new technology enterprise.

Keywords Core competence • High and new technology enterprise • Optimization management • Value activities

1 Introduction

Since Potter (1988) put forward value chain model (Potter 1988), value chain as is an important strategic tool has been widespread concern in the theory and practice of community. In recent years, domestic and foreign scholars applied value chain theory thinking to the middle organization management, such as union, virtual enterprise and supply chain, and formed research results of enterprise "value network". However, current enterprise value activities research still focused on

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industry positioning and competing with other businesses relationship management and that is "external argument" of typical sustainable competitive advantage, which conflict in concept of resource capacity of sustainable competitive advantage come from interna (Wernerfelt 1984; Prahalad and Hamel 1990). In fact, the competitive advantage can be obtained through a variety of sources of rent both internal rent and enterprise rent (Liu et al. 2008). Optimizing the layout of internal value activities reflecting the core competence featuring (Yu and Cui 2003) and external value activities around the development of core competence became a strategic task of the companies complement each other (Lin and Li 2003).

In the era of knowledge economy, high-tech enterprises are in a more complex competitive environment and its core competence are facing the dual pressures of rapid promotion and Reconstruction. Therefore, these activities has important significance to effectively deal with all kinds of opportunities and threats and the sustained and rapid development of the comprehensive advantages (Wang 2005), such as featured evolution rounding the core competence, system optimization and upgrading of the internal and external value of the activity and integrating organizational efficiency advantage of a variety of value activities governance model (Williamson 1999).

2 Characteristics and Classification of High-Tech Enterprise Value Activities

2.1 Value Activities Characteristics

1. Value active contribution. As Potter (1988) said that not every value activities create value. In fact, the premise of value of activities to create value is to match with the core competence development of high-tech enterprises, thus value of activities reflecting the core competence are usually created the most value.
2. Value activities economy. The economic drivers of the value activities are differences. It can be divided into two types: scale-economical value activities and scope-economical value activities (Lavie 2006). In general, the value activities of the production processes reflect the characteristics of the scale economies and R&D activities reflect the characteristics of the scope economies.
3. Value activities associating. Judging from the spatial and temporal correlation, there are three relationships between the enterprise value activities: undertake relationship, parallel relationship and interaction relationship (Wang and Wu 2010).
4. Value activities affecting each other. Value activity interactions which obtain addition effects and substitution effects affect the value creation. Wherein, addition effects refers to a value activity has positive enhancement to another activity and substitution effects are manifested as a negative substitution.

2.2 Internal Value Activity Classification

The core competence is evolving knowledge capability system through organizational learning, knowledge accumulation and comprehensive application in the process of enterprises creating value (Adegbesan 2009). According to the degree of correlation with core competence, we can divide the value activities of high-tech enterprises into core activities, sub-core activities and general activities. The core value activities are an important carrier of the high-tech enterprise core competence and it is the strategic links of value creation; sub-core activities refer to value activities that have value creation potential, which are closely related to the core activities or supported by other dominant factors; the rest of helper value activities are general activities (Alvarez and Merino 2003).

2.3 Typical Collaborative Approach of External Value Activities

In order to effectively utilize external resources and respond to environmental change, high-tech enterprises usually conduct strategic cooperative by optimizing external value activities. Typical collaborative approach are strategic alliances, virtual enterprise and supply chain. As shown in Table 1.

3 Optimizing Layout of the High-Tech Enterprises Value Activities Based on the Core Competence

3.1 Optimizing Layout of Internal Value Activities

That rounding core competence features and level of high-tech enterprise, and conducting internal value activities optimize and layout are the key to play fully the core competence strategic leverage and enhance corporate value creation efficiency quickly.

1. Internal value activities optimization standards. First of all, we have to consider the characteristics and level of high-tech enterprises core competence, which is the premise of building a unique value activities (Newbert 2005); Secondly, we also analysis of the problems of internal value activities and room for improvement combined contribution, economy, relevance and value characteristics. Optimize standards of high-tech enterprise internal value activities expand around four dimensions of strengthen, weaken, additions and deletions (Grahovac and Miller 2009), as shown in Table 2.

Table 1 Typical collaborative approach of high-tech enterprises external value activities

Feature \ Mode	Strategic alliances	Virtual enterprise	Supply chain
Value activities contribution	Risk-sharing, benefit-sharing, complementary advantages, compensate for value creation strategy gap	Construct complete and effective value system and capture market opportunities rapidly	Relying on core competence and division of labor with other supply chain enterprises to improve the professional level of value creation
Value activities economy	Scope-economical	Scope-economical	Scale-economical
Value activities associating	Interaction relationship	Dispersed in different geographical, parallel relationship	Undertake relationship
Influence of internal value activities	Addition effects play key role and substitution effects play subsidiary role	Addition effects	Addition effects

Table 2 Typical optimize standards of high-tech enterprises internal value activities

Dimensions \ Standards	Features and level of core competence	Contribution	Economy	Associating	Interaction
Strengthen	Core activities of reflecting core competence	Value contribution exists floating space	Favorite to economic effects further development	Further strengthen association with other core areas	Strengthen addition effects or alternative low potential value activities
Weaken	Over the range of core competence can be affordable	Weaken make the value creation reduce small and costs can be significantly reduced	Value activities economy uncoordinated or non-economic	Existence some conflict with other value activities	Reduced substitution effect with the core value activities
Additions	Highlight core competence characteristics, promote core competence development	Form new value-added space	Meet the whole economy consistence of valve activities	Further strengthen association with other core areas	Strengthen addition effects or alternative low potential value activities
Deletions	Difficult to reflect the characteristics and level of core competence	Value creation low efficiency	Presence of economic conflict	No contact with the core activities	Exist completely substitution effects with core activities

2. Internal value activities layout. Optimization criteria focus on the trade-offs to define high-tech enterprise internal value activities, and the next to form value activities strategic layout around the core competence development. When conducting layout of the internal value activities, first of all, we still have to highlight the characteristics of the core competence and layout strategic links reflecting the core competence (Chen and Wang 2007); secondly, layout the sub-core activities, which effectively match core activities or has the potential for value

creation; finally, consider the necessary general activities layout (Humphrey and Schmitz 2002). At the same time, the layout of the internal value activities also depends on the level of high-tech enterprise core competence, so we can accurate locate the internal value activities boundary of high-tech enterprises followed the leverage effect strategic logic of "core competence → core products → core business → specific products" (Prahalad and Hamel 1990).

3.2 Collaborative Approach Optimization of External Value Activities

Strategic alliances, virtual enterprise and supply chain have its own efficiency boundary. High-tech enterprises precisely choose one or several collaborative approach to build its external value of the active network. Thus, based on high-tech enterprise core competence characteristics, organizational capabilities complementarities and Integration of different values to create advantages of external value activities collaborative approach are conducive to better play to the high-tech core competence.

External value activities collaborative approach of high-tech enterprises are essentially intermediate forms of organizational governance, thus, the key is to examine the organization efficiency of these collaborative approach. Combined with inter-organizational core competence complementary and value activities characteristics, the collaborative approach organizational efficiency are mainly affected by the comprehensive influence of the benefits, costs and risks. Among them, income is the additional effect, scope and scale economy of the external collaborative approach to high-tech enterprise value creation and certainly cooperative partnership into will reduce earnings. Costs include inter-enterprise collaboration management costs and external collaboration will save the investment cost of high-tech enterprises. Risks include the alternative risk to the high-tech enterprise internal value activities and it can reduce the risk of operating independently through the risk-sharing mechanism. Generally, Organizational efficiency key factor change of three types of external value activities collaborative approach is shown in Table 3.

4 Optimization and Upgrading of High-Tech Enterprises Value Activities Based on the Core Competence

Around the core capacity development process and dynamic trade-offs and layout to the internal and external value activities continuously, thus it can achieve high-tech enterprise value activities optimization and upgrading.

Table 3 Key factors comparison of external value activities collaborative approach optimization

Organizational efficiency factors \ Collaborative approach		Strategic alliances	Virtual enterprise	Supply chain
Income	Addition effects	Big	Middle	Small
	Scale or scope economies	Small	Middle	Big
	Revenue sharing	Big	Middle	Small
Cost	Management collaboration cost	Middle	Big	Small
	Investment cost reduction	Middle	Big	Small
Risk	Substitution effects	Big	Middle	Small
	Risk-sharing	Big	Middle	Small

4.1 Value Activities "Refocusing" Around the Core Competence Upgrade

Value activities "Refocusing" refers to build the most efficient and competitive activities and unique value activities course around the core competence upgrade of high-tech enterprises. With the characteristics and level of core competence gradually increasing and corresponding the mix value activities and scope need to continue dynamic optimization, so as achieve the ability and value activities to enhance the synchronization. Thus, value activities "Refocusing" is dynamic movement of value activities boundary based on the high-tech enterprise core competence. It mainly includes: firstly, as the core competence supporting role increasing, more distinctive internal value activities upgraded to core activities; secondly, because of the boundary of the internal value activities subject to the features and level of core competence, the activities that are difficult in creating value will gradually externalize; thirdly, when the inter-organizational conducting value activities division of labor based on core competence, the high-tech enterprises build a more efficient external value network, and the leading role in the value network gradually improve according to dynamic preferred to the external value activities collaborative approach.

4.2 Value Activities Reengineering Around the Core Competence Reconstruction

With the intense changes in the competitive environment, High-tech enterprise core competence face reconstruction and corresponding value activities also need to

Table 4 Value activities upgrade of high-tech enterprises based on the core competence

Enterprise core competence development	Value activities optimization process	Upgrade type of value activities	Upgrading of internal value activities	Upgrading of external value activities
Promotion process	Value activities "refocusing"	Technology upgrades	With core process	Synchronization upgrade other matching process
		Product upgrades	Produce more core products	Other supporting product upgrades or rapid transfer high value-added products
Reconstruction process	Value activities reengineering	Functional upgrades	Upgrade the value sectors of high-value-added or expand the original value	External value collaborative approach and task updates
		Chain upgrade	Layout unique value activities	Recycling matches the external value network

recycling, that is to say, we need also concerned about the internal value activities re – layout and the external value of collaborative network evolution. Around the new core competence reconstruction process, the high-tech enterprise value activities recycling task mainly includes three aspects. Firstly, we need to highlight the value activities carrying new knowledge and skills especially with the prospects for the development of sub-core activities, and upgrade more to the core activities. Secondly, for these important sub-core activities which is difficulty in obtain support from new core competence, we usually chose strategic alliances to quickly make up. Thirdly, we will give up the worthless value of general internal activities and external collaboration inefficient way.

High-tech enterprises are facing more intense competitive pressures of globalization, that effectively integration into the global value chain and achieve rapid upgrade is the major strategic approach to rising international competition (Chen and Wang 2007). Learn from Humphrey global value chain upgrading classification (Humphrey and Schmitz 2002), we can divide value activities upgrade process of high-tech enterprises into four stages based on the development of core competence: technology upgrades, product upgrades, functional upgrades and chain upgrade. Among them, value activities "Refocusing" belongs to technology upgrades or product upgrades and the Value process of activities reengineering can be achieved chain upgrade. Corresponding relation is shown in Table 4.

5 Conclusion

In the era of knowledge economy, the high-tech enterprises are facing more complex competitive environment. So, only around the characteristics and evolution of its core competence, optimize the layout and continue to upgrade of the internal and external value activities, can high-tech enterprises achieve comprehensive advantages quickly enhance and sustainable development. Firstly, not all of the value activities in creating value. According to the match with the core competence, internal value activities are divided into core activities, sub-core activities and general activities. The typical collaborative approach of external value of activities includes union, virtual enterprise and supply chain and each approach also have its efficiency boundary. Secondly, Based on the features and level of core competence and combined with the characteristics of value activities, we can prefer the internal value activities by strengthen – weaken – increasing – excluding and take strategic layout following the core activities, sub-core activities and general activities. The optimization of synergistic manner external value activities depends on the organizational efficiency and the selection is mainly combined effected by the benefits, costs and risks. Thirdly, around the core capabilities and Reconstruction, we can refocus and recycle the value activities and form different upgrade way of high-tech value activities. The results show that dynamic management of high-tech enterprise value activities based on the core competence has some theoretical and practical significance. Certainly, in this paper, we carried out the theory exploration about enterprise value activities based on core competence and used the method of single-case analysis and demonstration, which is limited to practice management of high-tech enterprise value activities. In the future, we need to strengthen the research about optimization models and methods of value activities.

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Main Problems and Their Marketing Countermeasures of China's Domestic Luxury Brands

Tao Wen

Abstract China is the largest luxury consumption market in the world. It need and should have some domestic luxury brands. The paper describes the status of luxury market in China, introduces the concept of luxury and its brand characteristics. The paper also analyzes three main problems which the domestic luxury brands face, namely, conceptual problems, historical problems, enterprises' problems. The paper finally puts forward marketing countermeasures according to the problems mentioned above.

Keywords Luxury brands • Main problems • Marketing countermeasures • Online brand shops

1 Introduction

A few years ago, there is a constant controversy about luxury among the media and the people. Nowadays, China has become the largest luxury consumption market overtaking Japan and America. According to the latest World Luxury Association official report published in 2011, it shows: as of the end of December 2011, the total annual consumption of China's luxury market had reached $12.6 billion (not including private jets, yachts and luxury cars), accounting for 28 % of the global share. As a result, China has become the largest country of luxury consumption in the world (Yue-tan 2012). Faced with China, such a big luxury market, since 2004, the oversea luxury brands have been flooding in. From luxurious cars and jewelry to exquisite clothing, cosmetics, the luxury products are almost everywhere.

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However, it is hard to find China's domestic luxury brands. After all, the real masters in China's market are China's enterprises. China is in a dire need of the domestic luxury brands that can stand up to the foreign brands.

2 The Concept of Luxury and Its Brand Characteristics

Luxury means consumption products of the top brands that are beyond the normal need of people's daily life and that are unique, rare and very exquisite (Li 2005). In economics, luxury indicates the products with the highest ratio of value to quality. From the point of marketing, luxury means the products with highest ratio of intangible value to tangible value (Ni et al. 2004). Luxury refers mainly to luxurious cars, jewelry, clothing, cosmetics, liquor, leather goods, watches and clocks, etc. Generally speaking, when consumers buy the products above, they want not only to satisfy their practical need, but also demand to show off. In the past, luxury belonged to the noblesse and it was the symbol of status, identity and power. Nowadays, with the development of society and economy, especially middle class growing up, luxury becomes the symbol of pursuing individuation. Compared with the common brand, aside from the characteristics of high price, low output, high quality and having cheap substitutes, the luxury brand has some important brand characteristics as follows:

2.1 Symbol

In the past, luxury belonged to the noblesse, it was the symbol of status, identity and power. Nowadays, luxury is possessed by rich class and becomes a symbol of success in career. For example, the white-collar class usually shows off its success in career by buying luxury such as luxurious cars.

2.2 Temporariness

One luxury is not static but dynamic (Berry 2005). The luxury of yesterday may become the necessities of today. About 20 years ago, the laptops of IBM were luxury for the Chinese families. Today, IBM's laptops are just necessary studying tools for many families.

2.3 Culture

The biggest difference between luxury brands and ordinary brands is not price but culture. The culture of a luxury brand comes from its historical value, traditional culture and social concept contained. The longer the history of a luxury brand is, the richer its culture and the higher its value will be. By exploring its growth course, it is easy to find that every luxury brand has many stories behind it.

2.4 Specificity

The luxury brand is very exclusive and can never extend at will. It usually focuses on a product or a type of goods. It is rarely seen the successful case about luxury brands extending to other fields. Brand diversification may be effective to ordinary brands, but it never works for luxury brands.

2.5 Minority

In market positioning, luxury brands aim at rich class only. Benz, as well as Rolex, is such a brand. The charm of the luxury brand lies in that only a few of persons possess it while most dream of it. The practice has proved that only by making a strong contrast between the amount of people who know it and who have it can the luxury brand become the luxury brand in consumers' mind.

3 Main Problems that China's Domestic Luxury Brands Face

In China, such a big luxury market, China's enterprises have the natural advantages to build their own domestic luxury brands. However, when foreign luxury brands swarm into China one after the other, we can seldom see our domestic luxury brands. What on earth are the problems that barred the growth of China's domestic brands and made them in silence?

3.1 Conceptual Problems

China's past social movements branded deep scars in people's hearts. At the mere mention of luxury, people will relate it with the extravagant life of bourgeoisie and partially think that luxury equals waste. This old social concept has seriously blocked the growth of China's domestic luxury brands and caused a vacancy in China's luxury brands for a long time. In fact, luxury is a neutral word and it does not contain any derogatory ingredients. Luxury is relative, today's luxury is tomorrow's necessities. Luxury stands for a kind of life attitude. Pursuing high-quality life is everyone's dream and right. Of course, people should consume the luxury products according to their own abilities.

3.2 Historical Problems

It costs much time to build a luxury brand and make people recognize the brand. Oversea luxury brands usually have a long history. For example, Armani was born in 1970s, Gucci in 1923 and Dior in 1946. On the contrary, China's domestic brands lack historical accumulation and practical experience in marketing. As for jewelry brands, from the beginning of China's foundation to 1980s, China restricted the jewelry trade, which restrained the development of jewelry industry to a great extent. When selecting jewelry brands, people will firstly think about Cartier from Europe and Chou Tai Fook from Hong Kong, rather than domestic brands.

3.3 The Problems of Enterprises

1. *Short-term profits are emphasized while long-term profits are ignored*
   In luxury brand marketing, some China's enterprises take orders from the market and sell what the market needs. Relying on the market one-sidedly is hard to establish enterprises' unique brand characteristics. Once the consumption hotspot changes, it is hard for the enterprises to survive in the end. Through the growth course of the oversea luxury brands, we can easily find that the success of the luxury brands is mainly dependent on their long-term strategy and creating demand, that is to say, letting the luxury brands become the centers with the market turning around, rather than letting the luxury brands encircle the market. For example, setting limit to publication is a usual way for oversea luxury companies to stimulate the consumers' potential demand.
2. *Tangible value is emphasized and intangible value is ignored*
   Luxury indicates the products with the highest ratio of intangible value to tangible value. Comparatively, intangible value, which includes fame, history, culture, intellectual property rights, etc., is more important to the luxury brands. When choosing two directions of value mentioned above, some China's enterprises often go to two different extremities. One extremity is that the companies attach much importance to tangible value. For instance, some companies rack their brains in improving some functions of the products, neglecting the protection of intellectual property rights. China's famous brands are cyber squatted frequently, which proves this fact. The other extremity, which virtually despises intangible value, is to magnify excessively the intangible value.

3. *Attaching importance to imitation instead of inheritance and creation*
   The luxury brand is a wonderful combination of traditional culture and modern culture. Traditional culture is the basis of the luxury brand while modern culture is the soul. Practice shows that only creating in inheritance can enterprises gain lasting success in building the luxury brands. At present, there is a phenomenon in China that imitation is prevailing. According to the phenomenon, experts point out sharply that domestic luxury brands of China are entirely Westernized. Concretely, many companies cut off the umbilical cord with traditional culture and regard foreign luxury brands as God. However, it turns out to be that these companies' brands can't get customers' recognition by imitation. It will be true that their brands will be kicked out of the market sooner or later. The competition does not believe in tears. In order to succeed in building luxury brands, China's companies not only need to absorb rich nutrients from traditional culture, but also need to search for new impetus from modern culture. It should be firmly kept in mind that inheritance and creation are always the motif of luxury brands.

4 Marketing Countermeasures of China's Domestic Luxury Brands

To the problems above, China's enterprises should take the following countermeasures

4.1 Enterprises Should Establish a Right Cultural Concept Based on Customer Experience

Concept is the precursor of action. For an enterprise, it is very important to establish a right cultural concept. Here, the cultural concept refers to the one based on customer experience, its purpose is to let customers gain the high-quality life experience. Specifically, the luxury brands which are provided by enterprises, should not become the labels of wealthy class, but become the means which are used by people to highlight high-grade lifestyle. The space-time survey program, which was broadcasted by CCTV on April 10, 2006, made a research on the main purposes of the purchase of luxury. The research showed that among the main purposes of the purchase, pursuing the quality of life occupied 51 %, pursuing the quality of products occupied 39 %, preserving face occupied 10 % (Fig. 1). Clearly, most people buying luxury are in pursuit of quality of life. In experience economy era, customer experience is the next battlefield besides price, and the luxury brand is no exception. Under the new situation, China's enterprises should catch the opportunities of experience economy actively, shake off the fetters of the

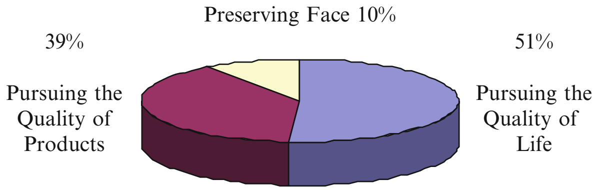

Fig. 1 The main purposes of purchasing luxury

old cultural concept, and establish the correct cultural concept based on customer experience, in order to let customers acquire high-quality life experience from the consumption of luxury brands.

4.2 Enterprises Should Make Marketing Strategy of the Luxury Brand and Push the Whole Work Designedly

An American strategist, Ansoff believes that strategy is a set of decision-making rules which are used to guide the enterprises' organizational behavior. Luxury brand marketing is an extremely complex project. Marketing strategy of the Luxury brand is the phosphor of brand marketing in the future. Without marketing strategy, the luxury brand will get into the short-sighted and blind situation. As for China's enterprises, to make marketing strategy of the luxury brand is helpful for them to regard the luxury brand marketing as a long-term project to implement. In other words, in the various phases and aspects of the luxury brand marketing, including market choice, brand awareness, brand image and brand relationship (relationship between the brand and the customer), under the direction of the luxury brand's marketing strategy, China's enterprises push the whole work forward designedly.

4.3 Enterprises Should Start from Reality and Take the Practical Marketing Measures of the Luxury Brand

1. *Enterprises should grasp market trends and target three types of customers*
   With consumer market of China's luxury keeping expanding, three consumer groups of the luxury are formed, Group 1, Group 2 and Group 3 (Chadha 2006). Group 1 is the important consumer group in China, this kind of customers are mainly businessmen, generally above 35 years old. As the upstart group, they generally choose the most well-known luxury brands. Group 2 is the growing group of consumers, this kind of customers are mainly white-collar workers and their ages are generally from twenties to thirties. They like to pay more attention to design, style and taste of the luxury brand. Group 3 is the main force of the luxury market in the future, this kind of customers are around 20 years old, they like to choose a different luxury brand to highlight their unique personality. In

the market targeting of the luxury brand, China's enterprises should do market positioning on the basis of the market and themselves. For most of China's enterprises, it is a more realistic choice for these enterprises to take Group 2 as the main market, Group 1 and Group 3 as the secondary market.

2. *Enterprises should emphasize combination of Chinese and Western, and create the noble image*
   Here, combination of Chinese and Western has two meanings. Firstly, on product development and packaging design, China's enterprises must highlight the characteristics of China's traditional culture. China's traditional culture is a great treasure trove of ideas, so China's enterprises should strive to draw rich nutrients from it. Secondly, in specialization and cross-culture marketing, China's enterprises should learn the advanced experience from Western countries' companies.

   Specialization and globalization must be a lesson for China's enterprises. However, it is not an easy task to integrate Chinese traditional culture and Western advanced experience to create the noble image which the customers admit. At this point, Swellfun and Guo Jiao 1573 have done a great success. They skillfully used the Chinese history and civilization, the legendary quality and origin, the international fashion tastes, and established the mysterious distinguished brand images in the minds of customers successfully. Of course, their success has provided valuable experience for China's enterprises to build luxury brands.
3. *Enterprises should use event marketing in order to enhance brand awareness*
   Event marketing means that an organization uses social hot spots to carry out public relations activities. Compared with the advertising, event marketing has many characteristics such as low cost, high reliability and dissemination of a wide range. For a company, on event marketing, it must pay attention to the three opportunities: opportunities of society, opportunities of media hot spots and brand itself opportunities. Audi firm's event marketing in Boao is the perfect embodiment of the action. During the period of Boao Forum for Asia held in April 2002, Audi A6 became the only designated VIP car. Audi cars showed the style of high-level luxurious cars and improved the brand awareness and influence through the window of Boao Forum for Asia.
4. *Enterprises should pay attention to brand experience in order to strengthen the relationships between customers and brands*
   Brand experience is the customers' experience for brands. Brand experience is a process that the customers contact with the brands. Brand experience has a direct impact on the quality of the relationships between the customers and the brands. Compared with the ordinary brands, luxury brands more emphasize the intangible value of products. Therefore, in the design of brand experience, China's enterprises must make sure that they put it in three places: First one is that customer participation is in place, second one is that personnel services are in place, third one is that scene arrangement is in place. Namely, in the designed scene, in the intimate one-on-one VIP services, customers can participate actively, truly find the enjoyment and happiness which is brought by the brands.

5. *Enterprises should build online brand shops in order to attract network customers from new generation*
   As of the end of December 2012, the number of China's internet users has reached 564 million. The large scale of internet users also provides a new opportunity for luxury network sales. As of the first half of 2012, the market size of China's luxury online shopping was up to 13.5 billion yuan, gained an increase of 58 % over last year, would reach 37.24 billion yuan in 2015 (Xiao-mi 2012). Especially in the current domestic economic downturn, China's enterprises should build their own online brand shops, rely on the facilitation and professional services to attract more network customers from new generation.

5 Conclusion

There is no exaggeration to say that the luxury brand is the symbol of the country's economic strength. China need and also should have some domestic luxury brands. With its rapid economic development and further improvement in the consumption environment, China's enterprises will certainly build a number of domestic luxury brands which have international influence as long as they do a good job mentioned above.

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The Establishment of "Out-Going" Enterprise Strategic Risk Recognition Model Based on Complex Network

Chun-hua Wang and Rong-yao Chen

Abstract Based on the statistical character of complex network, combining with the enterprise strategic risk environmental factors, an enterprise strategic risk network has been established to solve the problems that exist in the current global dynamic risk identification method. We also improved the statistical features of the relevant complex network and established "out-going" enterprise strategic risk identification model. In the end, we get the boundary conditions of the risk state transition caused by environmental factors through solve model.

Keywords Complex network • Strategic risk • Model

1 Introduction

Under the background of economy globalization, the Chinese enterprises are going out of the door to do overseas investment. Therefore, the enterprise strategic risk research is particularly important to overseas investment. Making a broad view of the China, the successful and failed cases on China's "going out" enterprise investment declare that: the "Going out" enterprises are lack of proper analysis and evaluation on strategy risks. On the one hand, the enterprises are lack of strategic risk awareness. On the other hand, the enterprise strategic risk study does not form a unified theoretical system, its connotation has not been unified in literature (Handong Li 2007). With the continuously heightened awareness of the strategic

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risks in practice, some method of measure strategic risk appeared successively, and also served as a warning to outgoing Chinese enterprises. After the analysis of all sorts of strategic risk such as financial, market, psychology, crisis management theory and the previous strategic management theory, Baird and Thomas (1985) argued that strategic risk connotation should cover all reasonable risk, but strategic risk is the different importance that the risk characteristics in show in different environment, also proposed a recognition model to recognize different situations (Baird and Thomas 1985). Baird modified multidimensional recognition model, and put forward the strategy contingency model in 1994, he always argued that strategic risk comes from the enterprise interior and exterior (Bird 1994). Winfrey and Bud (1997) suggested that strategic risk stems from the relationship among overall enterprise environment, resources environment and product market, also established the strategic risk system- multidimensional recognition model (Winfrey and Budd 1997). After the study of the strategic elements characteristic which is embodied by kaplan strategy map and the porter's value chain, the domestic scholars Liu Jianguo proposed strategic risk map based on the environment, resources, processes and strategic bottlenecks. It can recognize strategic risk by regression analysis to identify the key risk factors (Jianguo 2008) Shang Yingqiu systematically analyzed the domestic and foreign research on strategic risk identification and research the strategy risk mainly according to strategic matching thoughts or competitive advantage theory, strategic management process, the external environment and internal value creation process. Moreover, she proposed strategic risk identification element model which was formed all sorts of elements, analyzed and studied the strategic risk identification from more dimensions (Yingqiu Shang 2011). However it tended to be a qualitative research, rather than quantitative research.

In the strategic risk identification research, quantitative analysis is necessary. In the previous relative literature, many scholars given priority to a single static analysis, neglecting the dynamics of strategic risk and the uncertainty of the environment, mainly conducted from qualitative analysis. Under the background of economic globalization and information instantaneous changing, many scholars pay more and more attention to dynamic and quantitative research. The main strategic risk measure method (Shengfu Liu 2003; Simons 1999; Thomas 2004):

1. Capital asset pricing model (CAPM), mainly referencing finance research method to reflect the degree of enterprise strategic risk level by system risk level changes;
2. Improved CAPM method, its main idea is using the statistics of the variance to the overall risk level of enterprise risk;
3. Economic mathematics method, relative risk degree method is a typical method that mainly using economic risk measurement method;
4. Mathematical methods mainly contain fuzzy mathematics and AHP and grey relational analysis method. We can draw that the above methods analysis risk from one point, the methods used are only limited to a kind of risk.

Under the present background of economic information and globalization, the uncertainty of environment become more and more prominent, the dynamic nature of strategic risk should be reflected in research method. Based on the complex network theories and knowledge which developed rapidly in recent years (Xinhua et al. 2009; Yaowu Sun and Yingping Wei 2011; Xiaofan Wang et al. 2006; Zhang Da-wei et al. 2010; Watts and Strogatz 1998), we try to construct strategic risk identification model comprehensively and dynamically on the basis of previous research results.

2 Methodology

2.1 Enterprise Strategic Risk Factors

Enterprise development should rely on a certain environment. From the respective of enterprises, the environment includes macro and medium environment, the industry environment, and the internal environment. The macro environment is the root of influencing enterprise strategic choice. From this point, it is important for out-going enterprise to analyze the macro environment. The enterprise faces not only the domestic macro environment but also the international macro environment. The macro environment in this paper can be explained as follows: under the background of globalization, it was all sorts of environment containing domestic and oversea environment closely related to all out-going enterprises not only the macro environment of one certain enterprise. Namely, macro environment is political legal environment, economic environment and technology environment, social and cultural environment, and natural environment that out-going enterprise involved. For out-going enterprise, the macro environment research should be reflected in the medium, industry and enterprise internal environment study, the relationships between various factors are very complicated, and each factor may bring strategic risk to the enterprise. To sum up, environmental strategic risk factors in this research are various factors related to out-going enterprise. In order to study problem conveniently, we divided the environment factors into three levels, and selected representative environmental factors in each level.

2.2 Establish Enterprise Strategic Risk Network Model

1. *Network node model*
   We get enterprise strategic risk factors by the method of analyzing successful and fail Chinese out-going enterprise cases and the environmental scanning technology. These factors will be set to network nodes. As the following agreement: the macro environment is the first level factors, it means not only the macro environment categories but also means risk value. For example, x_1 is political legal environment, at the same time it indicates its strategic risk value; x_{ij}

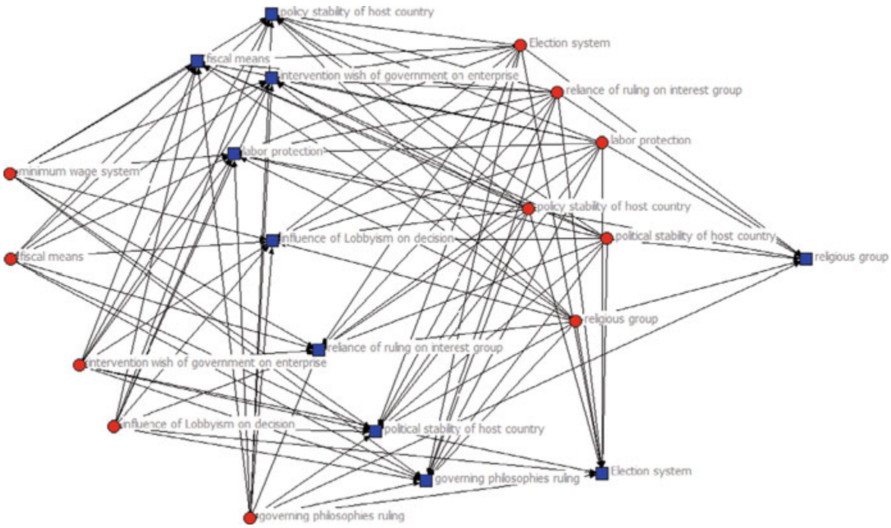


Fig. 1 Enterprise strategy risk complex network

shows the *j* primary factors of *i* macroscopic factors. x_{ijs} means the *S* secondary factors in *j* primary factors of *i* macroscopic factors.

2. *Enterprise strategy risk complex network*
   According to the relations among the primary level nodes, we put the related nodes together to form a simple network, and each node itself is also a network, which contains contained lower level nodes. Some relations existed according to the actual situation among these nodes. We abstract that this relationship as a side, so that the network contains a large number of nodes, and each node must be in accordance with the principle of interaction, the secondary nodes from different primary level will also has a certain correlation. These contacts maintain the existence of the whole network, so that we can study it as a complicated network. When going-out enterprise join the network with capital, technology and products, the whole network characteristics the characteristics of the whole network will change, because of the response of the network elements. In order to study conveniently, we take the going- out enterprise as a node join in the network, and we call the node as Q node. The node will be related with some elements, such as political, legal, economic and technical factors, also associated with lower levels nodes. Thus the going-out enterprise strategic risk network has been established. According to the current theory research of complicated network, and the research of each node and Q node in the network, we can research enterprise strategic risk dynamically. See the Fig. 1.
3. *Enterprise strategy risk complex network model*
   After the two steps above, a new network model has been formed. In this network model, we measured the node first. Then we can get all kinds of characteristics of the new network by researching the change of data and qualitative analysis.

Through studying the association between the node and Q node, also studying the whole network characteristics changes resulted by the side itself changes.

2.3 Enterprise Strategic Risk Network Measurement

Enterprise strategic risk network can be expressed by $G=(V,E)$, we supposed that there are N nodes, M side in the network, using $V=\{Q, v_1, v_2, \ldots v_n\}$ to express the set of nodes, the nodes are used to represent the related enterprise environmental factors. Using $E=\{e_1, e_2 \ldots, e_n\}$ to express the set of sides, each side represents the related enterprise strategic risk factors, and the weights of the factors express the size of enterprise strategic risks.

Node degree: in this model, it represents the number of nodes linked destination node. So the node degrees express the number of "going out" enterprise macro environmental factors which related to enterprise. The greater the degree is, the more environmental factors related to enterprise are, and the more influence in complicated network by other nodes are.

Node importance: the degree of the i node is expressed by k_i. Node importance reflects the importance of node in the complex network. Its computation formula is:

$$I = \frac{k_i}{\sum_{j=1}^{N} k_j}$$

The more the importance of the "going-out" enterprise is, the more significant the node in the network is, the lower the investment risk faced is. The less importance of environmental factors empress that the impact on the enterprise is smaller, the enterprise strategic risk will be lower.

Nodes gathered degree: it reflects the closeness between each node in the network. It can be used to distinguish the different levels of cooperation among each node. Meanwhile, it partly expressed the influence of the "going out" enterprise in different level brought by the macro environment factors. Namely, the higher the gathered degree is, the correlation between going-out enterprise and environmental elements would be closer. So the going-out enterprise will be influenced significantly and these environmental elements will be the indicator of the enterprise strategic risk. So we always hope the enterprise gathering degree as low as possible, and we can draw that the less the enterprise environmental factors are, the risk elements the enterprise facing will be less. The gathered degree calculation formula is:

$$A = \frac{3(k-1)}{2(2k-1)}(1-m)^3$$

k is the degree of the node, m is the average correlation probability, refers to the probability of the node establishing association with other nodes, and the probability of this association is determined by the market opportunities and government policy decision.

Node cooperation efficiency value: there are two kinds of network cooperation efficiency value. One kind is the overall cooperation efficiency value, refers to the efficiency sent out and transported by each node in the whole network. In complicated network, it used to represent the whole network of cooperation efficiency. Another kind is the local cooperation efficiency value. "Going out" enterprise overall cooperation efficiency value computation formula is as follows:

$$B = \frac{1}{n\,(n-1)} \sum_{ij} \frac{1}{d_{ij}}$$

If B is closer to 1, the result will be more ideal. The higher the overall cooperation efficiency value is, the whole network mutual dependence will be greater, so that they can achieve win-win results. The higher the whole enterprise cooperation rate is, the degree of the enterprise joining in to investor country will be bigger. Namely, the enterprise will get the favorable conditions in local development.

Node interface number: It is the ratio of number that the short circuit passing the node and the number of the whole shortest path in complex network.

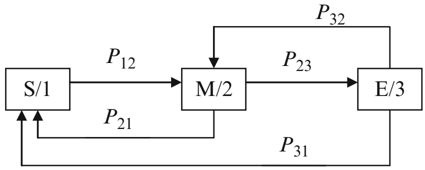
Side interface number: It is the ratio of number that the short circuit passing the side and the number of the whole shortest path in complex network. Interface number reflecting the function and the influence of the corresponding node or side in the entire complex network, is an important global quantity and has the very strong practical significance. The greater the number of node interface is, the influence the enterprise to the whole network will be greater, and the more energetic and more competitive the enterprise will be.

Edge's weight: generally, in complicated network, the least number of contacting the two nodes can be called the shortest path length. But in the enterprise strategic risk network, edge weights can't simply be expressed as the number of edge. In that case, we define in the edge of the weight, relative agile each node of the relative influence factors to defining the edge weight.

2.4 Enterprise Strategic Risk Identification Models

We established the enterprise strategic risk network, so we can describe the overall state of strategic networks by using complicated network statistics. Record the influence of node i on node j as w_{ij}. Recording the overall influence on node i as p_i, can be described as the state of the node. Due to the dynamic character of enterprise strategic risk network, the environmental factors influential value change with the time, so the node degree is a function of time. Set node degree

Fig. 2 Risk state transition relationship



$d_i = d_i(t)$, node interface number $m_i = m_i(t)$, clustering coefficient $c_i = c_i(t)$, so that $p_i(t) = g(\Sigma w_{ij}) = f_i(d_i, m_i, c_i)$ $0 \le p_i(t) \le 1$. In fact, each node of the network has different conditions at each moment, the bigger the gradient of influential value are, the node state which contacting it will be changed more easily, and the risk will be greater. According to the size of the influential value, we set the state of each node in the network to three states: influence low risk status (1 or S said), great influence risk status (with 2 or M said), and serious consequences risk state in 3 or E said. The state evolution process is as follows (Fig. 2):

Nodes state in strategic risk network is in constant change with time changes, when node status surpass a certain threshold, the node will present a new state, set P_{12} as the probability of state S translate to state M, P_{23} as the probability of the node M translate to E, P_{32} as the probability of the node E translate to M, P_{21} as the probability of the M node translate to S, P_{31} as the probability of the E node translate to S. From the risk state conversion diagram we can draw that, changes of the node state aroused by environmental factors can be divided into two stages. The first stage is $S \to M$, and the second stage is $M \to E$. They include the transformation to high risk level and corresponding measures that enterprise take to avoid or transfer risk, if the first stage risk state does not change, the risk state transition won't appear the second stage.

For the first stage, by the mean field theory

$$\frac{dp_i^1(t)}{dt} = -p_i^1(t) + (P_{21} - P_{12})\,\Theta\left(p_i^1(t)\right)k\left[1 - p_i^1(t)\right] + P_{31}p_i^1(t)$$

Set zero to the right of equation, the steady state value of above equation is:

$$p_i^1(\infty) = \frac{(P_{21} - P_{12})\,\Theta\,k}{1 - P_{31} + (P_{21} - P_{12})\,\Theta\,k}$$

$\Theta(p_i^1(t))$ suggest the probability of any node contact this node at moment t. here $\Theta(p_i^1(t)) = \Sigma kP(k)p_i^1(t)/\langle k\rangle$

Here $P(k)$ is degree distribution, according to the two equations:

$$\Theta = \frac{1}{\langle k\rangle}\Sigma kP(k)\frac{(P_{21} - P_{12})\,\Theta k}{1 - P_{31} + (P_{21} - P_{12})\,\Theta k}$$

Obviously, $\Theta = 0$ is a trivial solution of the equation, if the above equation has (a) nontrivial solution, the equation right first-order derivative above Θ will be greater than 1 under the condition of $\Theta = 0$, namely:

$$\frac{1}{\langle k\rangle}\Sigma kP(k)k\frac{(P_{21}-P_{12})}{1-P_{31}} = \frac{\langle k^2\rangle}{\langle k\rangle}\frac{(P_{21}-P_{12})}{1-P_{31}} \geq 1$$

So we can get the threshold limit value of first stage model:

$$\sigma_1 = \frac{\langle k^2\rangle}{\langle k\rangle}\frac{(P_{21}-P_{12})}{1-P_{31}}$$

For the second stage, by the mean field theory:

$$\frac{dp_i^2(t)}{dt} = -p_i^2(t) + (P_{21}+P_{32}-P_{23}-P_{12})\,\Theta\left(p_i^2(t)\right)k\left[1-p_i^2(t)\right]$$

Similarly, we can get the threshold limit value of second stage model:

$$\sigma_2 = \frac{\langle k^2\rangle}{\langle k\rangle}(P_{21}-P_{12}+P_{32}-P_{23})$$

Therefore, we can identify environmental risks (stated) by the threshold above, so as to provide a certain basis to avoid or transfer the risk for the out-going enterprise.

3 Conclusion

The article established the enterprise strategic risk complicated network by the help of relevant complicated network knowledge, (and) also combining the character of enterprise strategic factors. We also revised the statistical magnitude of complicated network characters to be appropriate for the enterprise strategic risk analysis. Furthermore, we established enterprise strategic recognize model and we (got) the threshold of risk state transition, when $\sigma > \sigma_1 = \frac{\langle k^2\rangle}{\langle k\rangle}\frac{(P_{21}-P_{12})}{1-P_{31}}$, influence low risk status changed to great influence risk status, when $\sigma > \sigma_2 = \frac{\langle k^2\rangle}{\langle k\rangle}(P_{21}-P_{12}+P_{32}-P_{23})$, great influence risk status changed to serious consequences risk state. The recognition model established by complicated network knowledge provided a new method to recognize the risk for out-going enterprise.

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A SWOT Analysis to Enterprise Strategic Management – Small and Medium-Sized Real Estate Enterprises as an Example

Ping Li and Hui-ying Gao

Abstract This paper not only points out the definition and process of strategic management, but also discusses the application process of the SWOT analysis in strategic management in detail. Specifically addressed the application process of the SWOT analysis Small and Medium-sized Real Estate Enterprises as an Example.

Keywords Enterprise • Management • Strategy • SWOT

1 Strategy Management

There are many definition of strategic management, such as "Strategy is corporate top management scheme developed for yield consistent with the organization's mission and goals" (Wright et al. 1992), Henry Mintzberg thought that the strategy has at list five definitions: the strategy is a plan (the expected strategic), direction, guide, forward line to the future, way from here to there and so on; the strategy is a pattern (accomplished strategy), that is, the long – term consistency of action; the strategy is a position, that is the positioning of special products in special market; the strategy is a perspective, that is an organization's basic way of doing things; the strategy is just the ploy, that is specific trick to defeating opponents or competitors (Mintzberg et al. 1998).

Strategic management involves not only the development and planning of strategies, but also contains the management to develop a strategic implement, so it is the whole process of management (Liu 2004).

The process of strategic management is generally divided into three basic stages: the formation of strategic, the implementation of the strategy and the evaluation of

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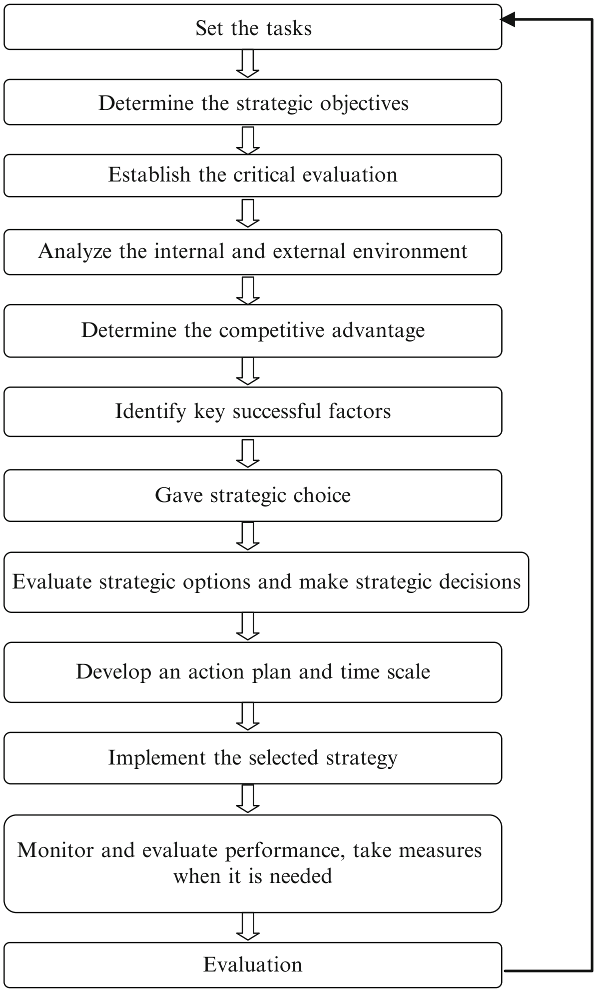

Fig. 1 The process of strategy management

strategic (Price and Newson 2003), and can also be divided into five steps: strategic ideas, strategic analysis, strategic evaluation, strategic planning, the adjustment and control of strategic implementation (Liu 2004). Johnson and Scholes further proposed the framework of the strategic management process (Price et al. 2003; Johnson and Scholes 1997), as in Fig. 1.

2 SWOT Analysis

Strategic management theory is widely used, especially in enterprise management. Implementing corporate strategic management has a variety of ways; this article mainly describes the SWOT analysis.

2.1 What Is SWOT

SWOT analysis was raised by the University of San Francisco's professor Weihrich the first time in the early 1980s. As to SWOT, it refers to a method which comprehensively considers various factors of internal conditions and external environment, carries out system evaluation, and then chooses the best business strategy. Over here, S refers to the internal advantages; W refers to the internal weaknesses; O refers to the external opportunities; and T refers to the external threats (Qinyuan Zhang 2006).

2.2 Who to Perform It

To carry out a SWOT Analysis effectively, a team consisting of members from various departments of an organization is usually required for the initial brainstorming session. The need for a team approach is largely due to the need for an effective integration of diverse domain knowledge from each department of the organization. In addition a team approach facilitates the convergence of ideas and directions amongst the different specialist department within an organization. In most case, the final summarization and integration may be done individually, usually in the hands of managers (Yinfeng et al. 2002).

2.3 Why to Use It

SWOT has the clear, concise, and specific characteristics, it is possible to reduce the waste of time and effort, for the reason that, SWOT wins the preferences of the business community, and becomes a common tool in the competition and business strategy decisions. SWOT provides a systematic approach to analyze intertwined various factors, although it is relatively simple, it is very effective. This has been proven by practice. The target of SWOT analysis is to identify the key factors of the enterprise's current strategy, the specific strengths and weaknesses, and then analyzes whether the new proposed strategy can deal with environmental change. SWOT analysis is not only able to confirm the key elements of internal resources and external environment, but also can carry out structural analysis. On the basis of a comprehensive grasp of the internal strengths and external opportunities and threats,

Table 1 SWOT analysis

External	Internal: Strengths	Weaknesses
Opportunities	SO strategy (the best one)	WO strategy
	1. Rely on internal strengths	1. Take advantage of external opportunities
	2. Take advantage of external opportunities	2. Overcome internal disadvantage
Threats	ST strategy	WT strategy
	1. Rely on internal strengths	1. Avoid external threats
	2. Avoid external threats	2. Reduce internal disadvantage

SWOT can draw up strategies in line with the organization's future development, in order to play to our strengths, overcome the weaknesses, take advantage of opportunities, and defuse the crises (Kewei and Lu 2008).

2.4 How to Use It

The enterprises make own SOWT analysis, generally follow the following steps: (1) Analyze the competitive situation of the industries they belong to; (2) What are the opportunities and threats the enterprise have when the external environment changes; (3) To identify the success factors of their own in the face of these opportunities and threats; (4) To carefully analyze the situation in terms of technology, human resources, management, and marketing, objectively understand their strengths and weaknesses; (5) To create and modify the enterprise strategy (Honglin 1993). The matrix of SWOT analysis as in Table 1.

3 Instance Analysis

A small and medium-sized real estate company how to use the SWOT analysis to understand the market, know themselves, and make themselves invincible in the competition.

3.1 Analyze the Environmental Factors

3.1.1 Strengths

First, occupy a large market share. According to national statistics, the number of small and medium-sized real estate enterprises is more than 90 % of the total number of real estate companies in China. If we use commercial housing sales and sales area to reflect the market share of the enterprise, the real estate industry has larger values of the dispersion. The market share of the top 100 Real Estate in the national market share is less than 10 %, as industry leaders, Vanke and Lujiazui Group have less than 1 % market share. On the contrary, the market share of small and medium – sized real estate enterprises is more than 70 %.

Second, have significant social values. Small and medium-sized real estate enterprises are an important source of state tax revenue and they meet a considerable proportion of the employment problem. What's more, small and medium – sized real estate enterprises use their own funds and bank loans for the development of the product to achieve the operation of the funds, realize the increasing in profits in the process of operation, and to create more economic value. Thus, they achieve the benign development of the capital, and the effective functioning of state funds can promote macroeconomic development.

Third, have strong flexibility. Small and medium – sized real estate companies are agile and quick decision-making. Because they do not have a pyramid management mode; they can make decisions without layers of approval.

3.1.2 Weaknesses

One, for the reason of that new land bidding policy is more stringent, and the strain on the resources of land, small and medium-sized real estate enterprises have more difficulty to access to land.

Two, enterprises have difficulties in financing, their mode of financing is single, and funding sources mainly depend on bank credit.

Three, market position is difficult, due to the limitation of land and capital, they are hesitant in the choice of which kind of product to develop, and they meet the great risk.

Four, have the shortage of talents. It is difficult for small and medium – sized real estate enterprises to provide high-paying, high benefits to attract talents. The contradictory situation of family management and system management in the enterprise is not conducive for the introduced talent to fully play their role, which leads to that it is difficult for enterprises to retain talents (Liping 2005).

3.1.3 Opportunities

One, due to the impact of the traditional concept, China's real estate needs become a rigid demand. Most people think that every family has a house is a matter of course, otherwise it would be seen as an unstable life, and a house even becomes the necessary hardware requirement for most men to get married.

Two, foreign businessmen come to China. Since China's accession to the WTO, foreign funds gradually flow into the Chinese market, especially after the 2008 Olympic Games, foreign investments in China become more enthusiastic.

Three, control the policy. China's housing prices soar, the state in order to curb price increases introduces a series of regulatory policies, the first one is restriction order, followed by "the State Council's Notice on Firmly Curbing the Surge in Housing Prices in Some Cities", "the five regulations of new country". In this policy environment, many big real estate companies have turned to commercial real estate, which undoubtedly leave some opportunities to small and medium-sized real estate enterprises.

3.1.4 Threats

One, international environment has big impact on Chinese market. The U.S. subprime mortgage crisis also has not just a few impacts on China's real estate market. The state makes more stringent supervision on real estate companies, which also makes it more difficult for the development of small and medium-sized real estate enterprises (Quanhe 2009).

Two, pressure brought by the large real estate companies. Whether from the financial strength, human resources, land resources or the influence, large real estate companies are stronger than the small and medium-sized real estate enterprises.

Three, capital chain is tensional. After the money put into a project, once the project occurs a bad situation, the capital chain is likely to be broken.

3.2 Response Measures

There is a small and medium – sized real estate enterprises SWOT matrix strategy matching table (Sheng 2009), as in Table 2.

In the first place, survive in the cracks. To seize the small projects which large real estate companies do not want to do.

And then, combine with other small and medium – sized real estate enterprises, they can learn from each other, mutual benefit and win-win. Combine with related industries, such as real estate development enterprises and manufacturers of building materials, decoration companies, property management companies combine together to form a real estate one-stop service to enhance the competitive strength.

Except that, they can develop new financing channels, do not lock the financing channels only in the bank, for example, they can bring in foreign investment.

The last but not the least, enhance their own from the aspects of business management, financial management, personnel management. Only strong enough can they guarantee being not squeezed out of the ranks of the fierce competition.

Table 2 Small and medium – sized real estate enterprises SWOT matrix strategy matching table

External environment / Strategy thinking / Internal condition		strengths	weaknesses
		1) occupy a large market share; 2) have significant social values; 3) have strong flexibility.	1) difficulties in accessing to land; 2) difficulties in financing; 3) difficulties in market position; 4) shortage of talents.
opportunities	1) rigid housing demand; 2) introduction of foreign capital 3) the opportunity brought by the industry's adjust	SO 1) combine; 2) survive in the cracks	WO 1) develop new financing channels; 2) develop new market.
treats	1) policy change strict since economic crisis; 2) pressure brought by the large real estate companies; 3) the tension of capital chain.	ST 1) to implement strategies different from the large-scale real estate enterprises'.	WT 1) enhance their own strength

4 Outlook

Due to the fierce competition of enterprise and the variability of operating environment, SWOT analysis also shows its flaws in applications, mainly in the factors judgment's fuzzification, factors analysis' fragmentation, and the reference of advantages and disadvantages is not clear, in addition, the most important problems are static analysis and the lack of quantitative analysis.

Since SWOT analysis method proposed, scholars constantly propose amendments on the lack of practical application of the SWOT analysis. Philip Kotler has proposed that the classification criteria of the opportunities and threats are different, the two are not the same coordinate axes at both ends; however, advantages and disadvantages are opposite. To distinguish between the two based on the same standard; they are both ends of the same coordinate axis (Kotler 1988).

Besides, William and Hunger summarized internal and external factors as external strategic factors matrix and internal strategic factors matrix, to try to solve the internal and external factors associated issues (Wheelen and Hunger 1995). In recent years, scholars' research of SWOT analysis' improvements mainly focuses on quantitative analysis and the sort of factors. Typically, the foreign scholar Mikko introduces the analytic hierarchy process into the SWOT analysis (Kurtila 2000).

How to solve the problems of static analysis? The lack of quantitative analysis and the correlation between the internal and external environmental factors need more in-depth thinking.

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Analysis of Competitiveness Condition of International Patents of Subsea Production Equipment

Tao Zhang and Jason Z. Yin

Abstract This paper analyzes the international patent status of subsea production equipment via aspects of the general trend of patent, patent country distribution, IPC structure and main patent applicants, etc., and put recommendation of technology R&D and industry development of subsea production equipment under the patent analysis. The analysis results show that international patent technology of offshore oil equipment has already been maturing. The United States, the United Kingdom, WIPO and Canada are the power countries of the patented technology of subsea production equipment with much more accumulated patents and maintain growth trend of patent applications. In particular in recent years, patent applications of subsea production equipment have rapidly increasing trend which indicates the arrival of a new round of technological revolution.

Keywords International patent • IPC structure • Patent layout • Subsea production equipment

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1 Introduction

Offshore oil and gas resources of the world accounted for 34 % of the total global oil resources, total proven reserves of about 40 billion T, proven rate of about 30 %, is still in the exploration of the early stages (Van't Hoff 1987).

Oil production is the last step and ultimate purpose of the undersea oil and gas exploration. Currently, there are four kind of oil recovery device used in the world: fixed production platforms, floating production systems, artificial islands and subsea device. In which the fixed production platforms are the most widely used.

Because of the limited depths of the platform, the limited number of life of wells on the platform, and the limited life of various service facilities, the wellhead of fixed platform cannot meet the requirements of being used in offshore oil exploration in the deep-sea. In order to develop deepwater fields, at present the subsea production technology and equipment have been adopted and developed.

The subsea production equipment appeared from the early 1960s. According to the different installation position of the oil extraction equipment, subsea production equipment can be broadly divided into three types: wet, dry and hybrid. The appearance of the whole tree being exposed to seawater is called the Wet tree of Oil recovery. The dry Oil recovery is covered with steel shell which can isolated from seawater. The Oil recovery of the mixed oil extraction equipment is placed in the platform and the rest of the installation in a certain depth of seawater or in the bottom of the sea. Due to the lower cost of manufacture and installation and the simple maintenance and overhaul of a wet oil recovery tree, it is always on top uses in the world (Liao 1995).

2 Acquisition of Patent Data

The patent data in this paper come from the patent information analysis database of the state intellectual property office (Intellectual Property Publishing 2012). We construct multiple search strategy by classifying and combination the retrieval way of the IPC classification number, technical key words, and the applicant, abstract, enterprise, and the inventors to search the public patents of the United States, Japan, Britain, Germany, France, Switzerland and Europe, the world intellectual property organization (WIPO) from 1915 to 12/2012. Through reading and analysis and data cleaning, 884 patents sample (including kin) are reserved. Because the whole time that from patent application to public usually need 1–3 years, the recent patent data is only for reference.

3 Patent Overall Trend Analysis

3.1 Figures and Tables

In general, total 886 application pieces of international patents are retrieved. The first patent was applied in 1915 and opened in 1916 whose name was "Improvements in Means for Automatically Indicating the Presence of Ice at Sea".

From Fig. 1, it is known that there are several high and low points in the international patents application of subsea production equipment. It can be divided into three stages:

The first stage from 1970 to 1983 was the initial growth period. In the seventy ages, because of the influence of the war in the Middle East, the worldwide energy crisis emerged and it promoted the development of offshore oil industry. All countries in the world have invested a lot of money and manpower in R&D to carry out subsea production equipment. Early production system was developed, such as the Brazilian oilfield which in more than 100 m depth. It succeeded in using subsea wellhead and floating production device to mining crude and obtained economic benefit (1990). At that time, there was an average of 12 pieces of patents application in each year. Compared with the period of fiftieth and sixtieth ages, there had a better growth. In 1979–1983 the number of patent application had an outbreak so that it reached the peak of 24 pieces n 1981.

The second stage from 1984 to 1997 was the transition development period. After the eighty ages, the oil supply exceeded demand so that the price of oil slumped. The offshore oil industry only reduced investment cost to get survival and development. Reflected in the international patent application, obviously we can see that the number of international patent application of subsea production equipment declined

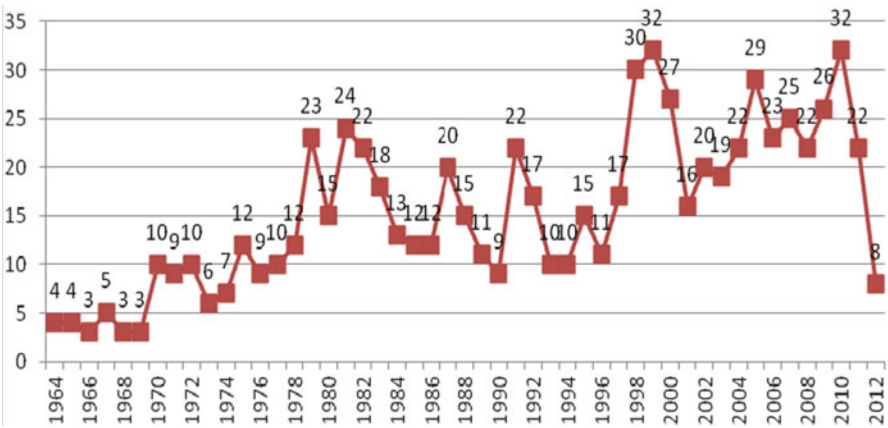


Fig. 1 The whole trend of patent application of subsea production equipment for nearly 50 years in the world

in this stage. Apart from in 1987 and 1991, the number of patents application had 20 pieces, in other years the average number of application only was 12 pieces per year. The floating production system and subsea technology which featured with fast production and low cost, were quickly produced (Xiao Shuxian 1990).

The third stage from 1998 to now is the rapid development period. Since the 1990s, the consensus of all countries turns to ocean resources especially the deep sea oil and gas exploration and mining technology has become the new direction (Zhou 2003). The twenty-first century is the century of the ocean. At present, the number of countries and regions in the world who explore and develop the Marine oil and gas increased from more than 80 to more than 100, owned investment funds $85 billion a year and increased in an alarming rate every year (Hou Guiqing and Sun Ping 1997). Reflected in the number of international patent application of subsea production equipment, except in 2001 and 2003 the number of application were lower of 16 piece and 19 piece, in other years the number were above 20 pieces every year. In an all, the average number remained in 25 pieces per year. In 1999 and 2010, the number reached the highest point of 32, which indicates that the new technology revolution is coming.

4 Country Analysis of Patent

4.1 Country Analysis of Applicant

Table 1 lists the national statistics of patent applicant in 13 countries. From the table data it can be known that, firstly, the United States played the most active in the patent application with total 289 patent applications much higher than other countries, showing that its scientific research strength is also the strongest in the world.

Secondly, the Britain owned 143 pieces of patent applications, the WIPO had 110, Japan had 107 pieces, and Canada had 83. That shows that the scientific research of four countries is also very strong, especially scientific research strength of Britain following with the United States.

Thirdly, EPO had 45 pieces of patents applications, Australia had 39 pieces, Spain had 30 pieces, which shows that these several countries own certain research and development strength. In addition, in the European Union countries, there are 7 pieces of French, 4 pieces of Russia, 2 pieces of Germany which showed that the European Union countries is only involved but not strong in the research and development of subsea production equipment.

While Asian countries had 10 pieces of southeast Asia, 22 pieces of Korea, it shows that coastal countries of east and south Asia also took part in the competition. All in all, the patent advanced technology of subsea production equipment was chiefly owned by the United States, Britain, WIPO and Japanese.

From Fig. 2, the first of US had 120 pieces of patents application and WIPO had 78 pieces; the second of GB and JP owned 44 pieces and 45 pieces respectively;

Table 1 Country statistics of patent applicant

Country of applicant	Amount of patent application	Accounting for %
US	289	32.44
GB	143	16.05
WIPO	110	12.35
JP	107	12.01
CA	83	9.32
EPO	45	5.05
AU	39	4.38
ES	30	3.37
KR	22	2.47
SG	10	1.12
FR	7	0.79
RU	4	0.45
DE	2	0.22
Total	891	100.00

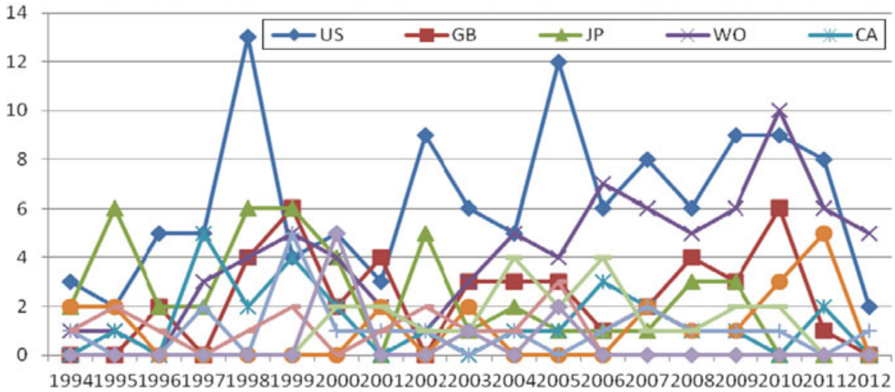


Fig. 2 Region trend of international patent applications of subsea production equipment in nearly 10 years

the third of CA, KP and AU were between in 20–29 pieces. The last of EP, ES and SG owned patents application under 20 pieces. All these shows that in recently 10 years, US still occupied the first chair of patent technology of subsea production equipment, and the WIPO exceeded GB with rapid improvement so GB and JP were at the same level.

4.2 Countries Statistics of Patent Open

The patent open number of subsea production equipment in major countries and international organizations in recently 20 years are listed in Table 2. It shows that the United States had the most of 125 pieces, accounting for 29 %; The second

Table 2 Country statistics of international patent applicants of Subsea production equipment in recently 20 years

Country	Amount of patent open	Accounting for %
US	125	29.00
GB	45	10.44
JP	50	11.60
WO	78	18.10
CA	33	7.66
AU	21	4.87
EP	22	5.10
ES	18	4.18
KR	22	5.10
SG	8	1.86
FR	4	0.93
RU	4	0.93
MY	0	0.00
DE	1	0.23

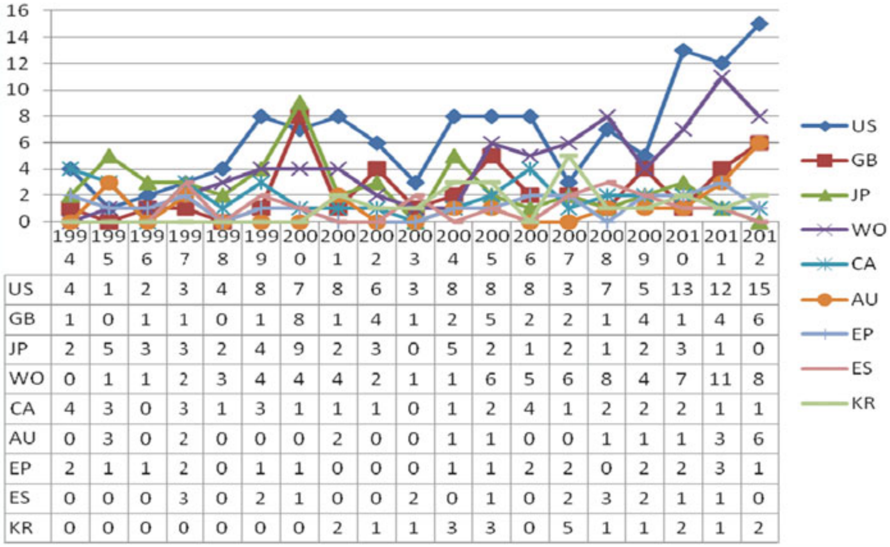
are WIPO with 78 piece, accounting for more than 18 %; British with 45 pieces, accounting for more than 10.44 %; the Japanese with 50 pieces, accounting for more than 11.6 %. Otherwise, Canada had 33 pieces, accounting for more than 7.66 %; Australia had 21 pieces, accounting for more than 4.87 %; the European Patent Office and South Korea had the same of 22 pieces, accounting for more than 5.10 % respectively. ES had 18 pieces, accounting for more than 4.18 %. Other countries had 13 pieces, accounting for more than 3.96 %.

Figure 3 shows the tendency of international patent open of subsea production equipment in the world's major countries and regions. As can be seen from the figure, the amount of Patent Public in US has been dominant from 2000 till now, especially in 2011 and 2012 the amount reached a peak. Following with the same trends of patent open as US, the WIPO has a continued growth from 2000 and also reached a peak in 2011 and 2012. On the contrary, the amount of patent open of the United Kingdom, Japan, Canada and the European Patent Office kept a relatively stable trend in the past 20 years. The Korea is a new one who joined into the R&D of subsea production equipment so it had the patent open from 2000.

4.3 Comprehensive Analysis

The countries or areas with more amounts of patent open means that there are the potential markets with big application value on patent technology while The countries or areas with active patent applicant are the birthplace of technology innovation.

On the view of quantity, the United States is not only the largest patent open country of subsea production equipment, but also the largest source country of patent technologies. Its amount of patent application (120 pieces) in recent 20 years



	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
US	4	1	2	3	4	8	7	8	6	3	8	8	8	3	7	5	13	12	15
GB	1	0	1	1	0	1	8	1	4	1	2	5	2	2	1	4	1	4	6
JP	2	5	3	3	2	4	9	2	3	0	5	2	1	2	1	2	3	1	0
WO	0	1	1	2	3	4	4	4	2	1	1	6	5	6	8	4	7	11	8
CA	4	3	0	3	1	3	1	1	1	0	1	2	4	1	2	2	2	1	1
AU	0	3	0	2	0	0	0	2	0	0	1	1	0	0	1	1	1	3	6
EP	2	1	1	2	0	1	1	0	0	0	1	1	2	2	0	2	2	3	1
ES	0	0	0	3	0	2	1	0	0	2	0	1	0	2	3	2	1	1	0
KR	0	0	0	0	0	0	0	2	1	1	3	3	0	5	1	1	2	1	2

Fig. 3 Patent discloses trend of subsea production equipment of major countries

was basically balance with its amount of patent open (125 pieces). Furthermore, the former was less than the latter. That shows on the one hand, the United States has a strong technical strength, on the other hand, American inventor not only applied for native protection of patent but also focused on patent layout in other countries and regions. At the same time, other countries think the United States as the important patent protection market.

The amount of patent application of subsea production equipment of Britain, Japan and the WIPO was more than their amount of patent open in recent 20 years. That shows that patent inventors in these countries and regions attaches great importance in patent application in overseas markets. Especially the number of patent public of WIPO (78 pieces) was four times of its number of patent application (19 pieces) so as to show the increasingly attention of the intellectual property protection in the world.

However, the amount of local patent open of the European Patent Office In nearly 20 years was greatly lower than Its amount of native patent application. That shows that European countries are very strong in the technology development but their patent strategies are so conservative that they seldom applied for patent protection in other countries or regions. Of course, other countries also haven’t layout patent in European countries. The same situations are in Canada, Spain, South Korea’s.

The amount of patent open of patent inventor in other countries, such as SG, FR and Russia, are balanced with their patent application, indicating that these countries patent inventors only apply patent protection in their nation, without patent layout in other countries.

5 Analysis of IPC

5.1 Analysis of IPC Composition

The following analysis is mainly in the IPC (international patent classification number) technology structure. International Patents of Subsea production equipment are mainly distributed in the E department of IPC (fixed building), accounting for more than 52 %; followed by H (electrical) department which accounted for more than 10 %, and F department (mechanical engineering) which accounted for more than 9 %.

On the view of the IPC small class, there are 397 pieces of international patent of subsea production equipment in E21B (soil or rock drilling), accounting for more than 44.56 %;136 pieces are In B63B (ship or other water ships, Marine equipment), accounting for more than 15.26 %; The other of 65 pieces are in H04B (electric communication technology, transmission), 54 pieces are in E02B (water conservancy engineering), 15 pieces are in F16L (engineering components or parts, pipe, pipe joint or pipe fittings, pipe, cable or protecting tube support; the general adiabatic method), 30 pieces are in B65G (transport or storage devices, such as loading or tilted in conveyor belt conveyor system, workshop, pneumatic pipe conveyor), 14 pieces are in G02B (optical components, systems or instrument), total accounting for more than 3–7 %.

The technology construction of IPC large group was shown in Fig. 4.

From Fig. 4, it is known that in the first, the technology field of international patent application of subsea production equipment are mainly in E21B33/00 (hole or shaft seal or packer, 217 pieces), E21B43/00 (methods or equipment of exploitation of oil, gas, water, soluble or melting substance or mineral mud from the borehole,148 pieces), E21B34/00 (the valve gear of hole or shaft,88 pieces), E21B17/00 (drill pipe; soft drill column; drill collar; sucker rod; casing; pipe, 54 pieces), E21B41/00 (equipment or parts not included in E21B 15/00 to 40/00 E21B group, 40 pieces). Others exit in E02B17/00 (artificial island on pile foundation or similar supporting content, such as, platform on the lift pillar; other building methods, 29 pieces),in E02B3/00 (engineering of control and utilization related of streams, rivers and coastal or other sea areas, 25 pieces).

In the second, there are in B63B22/00 (buoy, 64 pieces), B63B27/00 (equipment configuration of ship cargo or passengers, 50 pieces), B63B21/00 (bind system, equipment of mobile, dragging or pushing; anchor, 39 pieces), B63B35/00 (suitable for special ship or similar floating structure, 34 pieces).

Finally there are in H04B7/00 (radio transmission system, use of radiation field, 20 pieces), H04B3/00 (cable transmission system, 24 pieces).

In short, the technology trend of international patent application of subsea production equipment in recently 10 years focused on E21B33/00, E21B43/00, E21B34/00, E21B41/00, E21B19/00 and B63B22/00, B63B27/00, B63B21/00, B63B35/00.

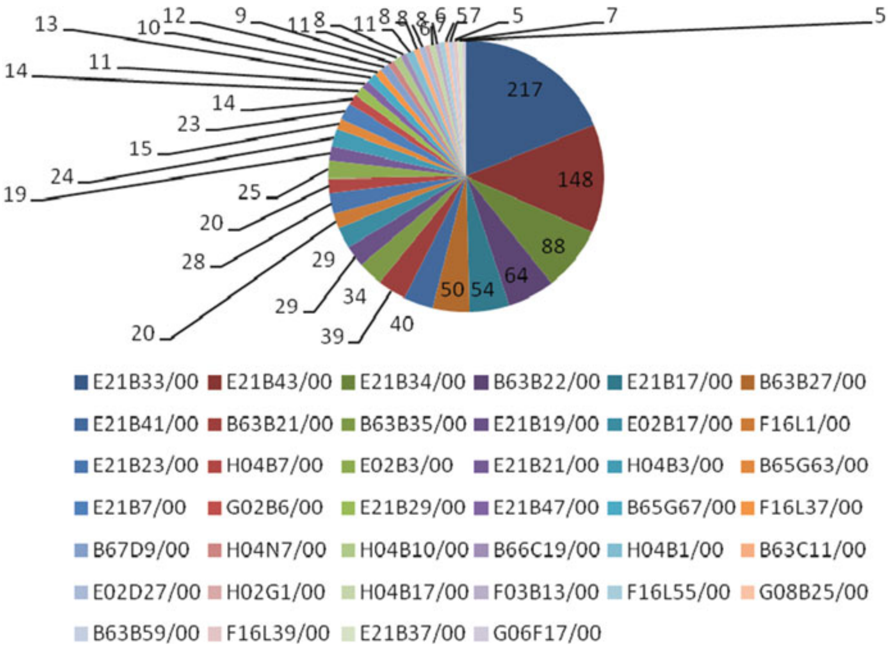


Fig. 4 IPC large group of international patent technology of subsea production equipment

5.2 *Country Analysis of IPC*

In Fig. 5, it is known that American patent technology of subsea production equipment focused on two parts, one is in E21B33/00, E21B43/00, E21B34/00, B63B22/00, E21B17/00, E21B41/00, E21B19/00, E02B17/00, the other is in B63B27/00, B63B21/00 and B63B35/00. Otherwise, GB patent technology focused on E21B33/00, E21B43/00, E21B34/00, B63B22/00, E21B17/00 group.

The United States and GB have the almost same patent technology strength. However, not only the scope of GB patent technology is narrower than the United States, but also its patent quantity is less than US. Compared to other countries, GB is still far higher than other countries in the technology scope and the number of patent application. It shows that the United States and Britain are worthy of the power countries in patent technology of subsea production equipment.

The patent technology fields of WIPO, CA, AU and EP, SG are concentrated in the E21B33/00, E21B43/00.

To Japan, ES and KR, there are some patent applications in H04B3/00. In addition, Japan also has more patent application in B63B35/00, B63B22/00.

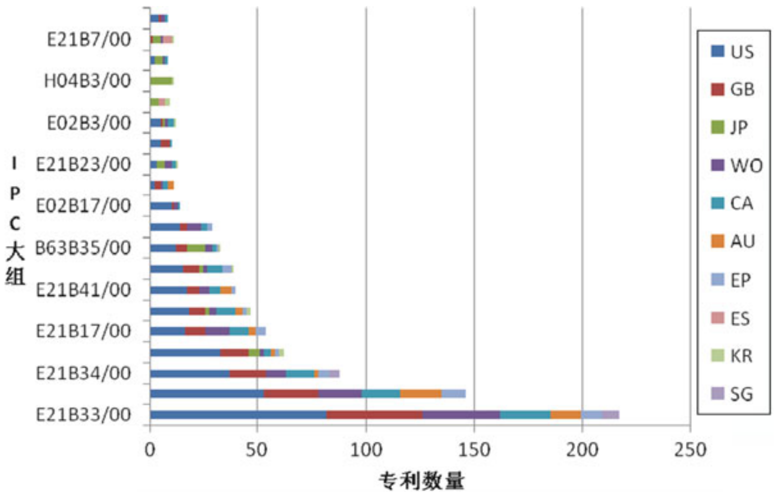


Fig. 5 Country analysis of IPC group of international patent of subsea production equipment

6 Analysis of Main Patent Holders

Table 3 lists the top 15 international patent holders of subsea production equipment. In them, there are 60 % of American companies, two JP companies, and each one company of Britain, Brazil, Canada and Taiwan.

Explanation of each indexes of R&D ability:

A. active years – means of the number of active period when competitive companies have their patent output in this technology research and development time so as to know the R&D time the company is in this technology field;
B. the amount of inventor – the number of inventors the competitive company put into R&D so as to assess the human strength and potential competitiveness;
C. Average patent age – the patent number divided by the patent age. The shorter average age is owned by a patent, the stronger monopolistic advantage of patent technology is owned by the company.

From the Table 3, it is known that American FMC CORP not only owns the largest number of patents of subsea production equipment, having absolutely patent technology advantage in E21B, B63B and F16L, but also has the research and development team with the largest number of persons and the longest R&D activities years. All indicates that it is the oldest in this research field and has the strongest R&D ability.

Although the R&D activities years of American SCHLUMBERGER holding CO., LTD., EXXONMOBIL UPSTREAM RES COOP, FMC TECHNOLOGYS

Table 3 Comparative analysis of international competitors of Subsea production equipment

Applicant	Patent number	R&D ability of applicant		
		Active years	Amount of inventor	Average patent age
FMC CORP (US)	76	14	121	19
PETROLEO BRASILEIRO SA (BA)	28	6	75	19
MOBIL OIL CORP (US)	36	10	49	39
VETCO GREY INC (GB)	18	10	22	10
SCHLUMBERGER TECHNOLOGY CORP (US)	25	12	36	13
NEC CORPNEC CORP (JP)	17	10	17	22
FMC TECHNOL OGIES (US)	22	7	31	10
VETCO OFFSHORE IND INC(CA)	13	8	49	34
EXXON PRODUCTION RESEARCH CO(US)	12	8	61	35
AMTEL INC	9	4	8	31
EXXON MOBIL UPSTREAM(US) RES CO	8	4	38	7
DRIL QUIP INC(US)	10	6	19	16
SCHLUM BERGER HOLDINGS	8	3	21	3
MITSUBISHI HEAVY IND LTD(US)	8	8	22	18
CAMERON IRON WORKS INC(US)	9	3	12	32

CO and PETROLEO BRASILEIRO SA are not enough long, their average ages of patent are short, especially having obvious new technology advantage in E21B. So we can indicate that these companies increased the R&D investment in recent years. In particular, PETROLEO BRASILEIRO SA, the rising star of technology, is one of few companies in the world which can develop oil and gas in deep water and occupies the leading position of high technology of deep sea mining. It designed, manufactured and installed the floating platform which created the miracle of mining out oil in 1,027 m deep sea area (Mo Jie 1997).

Comparison with the former companies, the MOBIL OIL CORP, EXXON PRODUCTION RESEARCH Corp, and CAMERON IRON WORKS INC, and Canadian VETCO OFFSHORE IND INC also owned more patents in E21B, but their average age of the patents exceed to 30 years while the R&D active years are short so as to be known that they are the new entrants in this technology field.

NEC CORPNEC CORP and Taiwan AMTEL INC have some patents in H04B, but the average age of the patents is much longer so as to be known that their monopolistic advantage on the technology is not strong.

7 Conclusion

Through analysis of the international patent of subsea production equipment, combining with the current development status of subsea production technology, the following conclusion are drawn.

1. Patent technology of subsea production equipment tends to mature and emerging technology has a rapid development

   There has been nearly 100 years in development on Subsea production equipment from the laboratory research to industrialization since 1915. But in the twenty-first century, company with the Marine oil and gas production going from shallow to deep sea, the requirements of emerging technology is becoming greater. Corresponding to patent application, its figure has a sustained growth so it indicated that the research and development of deep sea production equipment technology is in a rapid development period.
2. The patent technology of subsea production equipment has been mainly owned by the European and American countries, such as the United States, Britain, WIPO, Japan, Canada, and so on

   The United States, Britain, WIPO, Japan, Canada, etc. are the countries who began to research and develop the technology of subsea production equipment early. On the view of data, the United States has the most amount of patent application, and the application number per year has been in constant growth so that it had peaked in 2011 and 2012. All these indicate that the United States has the first lead position in technology of subsea production equipment. The UK, following with the USA, has been the second lead position in patent technology field of subsea production equipment. The patent application of WIPO and South Korea has been in rapid growing since 2000. And Japan also has a leading position at the bottom of the communication technology.
3. The concentration areas of patent application of subsea production equipment technology is in E21B

   Although the technologies of Subsea production equipment involve in many relatively IPC classification, the total amount of patent application in E21B33/00, E21B43/00, E21B34/00, E21B17/00, E21B41/00 has accounted for 66 % of all. In these the amount of technologies in E21B33/00 and E21B43/00 accounting for 39 %, is a priority area of technology.
4. The American companies are the patent holders having the strongest technology of subsea production equipment

   American companies are in 60 % in the 15 of the world's leading patent holders of subsea production equipment. FMC Corporation is the company who has the most amounts of patented technology of subsea production equipment and the worldwide strongest technology of subsea production equipment. Schlumberger Holdings Limited, ExxonMobil Upstream Research Company and FMC Technologies are the rising stars in R&D of subsea production equipment having more emerging subsea technologies.

In recent years, MOBIL OIL CORP, EXXON PRODUCTION RESEARCH and CAMERON IRON WORKS INC also joined in the army of the R&D of subsea production equipment.

5. Currently technology of deep-sea oil extraction is the focus of research and development

The deep sea area with depth of more than 300 m is the most abundant virgin land of oil and gas mineral so that 44 % of total oil and gas in the future will come from the deep sea area. According to the statistics of the paper "deepwater found of the U.S. Gulf of Mexico" on American "Offshore" in January 2005, in 13 years from 1982 to 2004, there were total 118 oilfields founded in deepwater in the U.S. Gulf of Mexico (Liao Moshen 2006). In recent years, the global exploration and development of Marine oil and gas has gradually developed from 300 m in the shallow sea area to the deep sea area. According to forecast of foreign authorities, currently the maximum depth of the known deep sea drilling has reached 3,053 m while the development depth reached 2,292 m. But at present, there are few countries really owning the manufacturing ability of the ocean development equipment in the world. As far as the underwater processing system is concerned, its production suppliers only concentrate in the United States, Norway and some developed countries (Wu et al. 2012).

For example, American Shell Oil Company's level of operation technology in the deep sea area is in the leading position in the world. In early 1996, the company has the exploration and development of oil and gas of Ursa block in depth of 1,200 m of Louisiana offshore.

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Industrialized Culture, the Development of Regional Symbols in Tourism Economy – Traditional “Frog Pattern” in Hainan Province

Ya Dong and Ying Guo

Abstract Regional symbols are the simplest visualized summary of the local cultures. After the arising of the cultural industry, all regions have focused on combining regional symbols and the local cultures, which can undertake part of the economic functions. Through comparing the statistics and the demonstrating Lorenz Curve, this article will discuss the transformation of public tourism under the stimulation of cultural industry. This article will elaborate the conditions of building regional symbols based on cognitive psychology theories, and explain how public’s recognition of regional culture promote public consumption, showing public’s recognition of regional symbols equals the recognition of regional cultures. The article will discuss Hainan Li people’s “Frog Pattern”, and analyse the driving effects of regional symbols to tourism economy.

Keywords Cultural industry • Regional symbols • Tourism economy • Transformation

Affected by international financial trend, the economical and industrial structures in our country are adjusted. Culture has gradually melted into our modern economic structure as a third industry. Briefly speaking, culture is the feature and history of a city, and in the mean time, culture plays the role as a guide of the regional economic development. In other words, one city’s economic benefits will directly be influenced by how the city’s cultural industry is developed (Zhao et al. 2006). The eighteenth National Congress of the CPC meeting stresses that “Cultural industry is going to be a national fundamental industry”. Hence, local governments turn the goal of development into uniting regional culture and the modern design based on protecting historical relics.

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The term “Cultural Industry” was first coined by critical theorists Theodor Adorno and Max Horkheimer in *Dialectic of Enlightenment*. After that, UNESCO (United Nations Educational, Scientific and Cultural Organization) defined it as the various businesses that produce, store, distribute market or sell products that belong categorically in creative arts. The *Opinions about Supporting and Promoting Cultural Industry Development*, published by China Ministry of Culture in September, 2003, defined it as an improving and emerging industry, developed in modern modes of production with the perfection of socialist market economy in China (Hu 2009). Nation Bureau of Statistics in China stressed that cultural industry was the set of activities that provide the public cultural and entertainment products and services. Until 2011, the cultural industry had gained its value added up to 1347.9 billion RMB. *Annual Development Report of Cultural Industry in China* showed that, in 2012, domestic cultural industry output in China had break through four trillion RMB, there into, tourist industry and education and training industry occupied with big proportions of 46 and 17 % in the market.

Even though above statistics shows that cultural industry has a great potential of making profits, tourist industry covers almost half of its market share as one of its branches. And yet, tradition tourist industry exists its own disadvantage of producing environmental issues of excessive consumption of natural resources and expanding ecological deficit. To this light, breaking loose from traditional tourist industry, and promoting cultural tourist become the trend and initial focus of modern tourist industry. As support unit, Nation Bureau of Statistics in China published the new revised standard of *Classification of Cultural and Related Industries (2012)*, with cultural industry as the fifth category presented in the ten categories for the first time.

China is a country with multi-ethnic groups and diverse cultural backgrounds. Different traditions and images come into its own existence. These images are indeed the core expressions of the different regional cultures, customs and beliefs. So, traditional symbols can be considered as the embodiments of multi-element and regional cultures. Today, it is an important means to develop regional symbols, transform regional symbols into products, and highlight the local characteristics based on cultural tourist.

Nevertheless, most of the regional symbols are with complicated curves and difficult to be produced as a single product, which means it can only be attached to other products. This process, however, not only affects the inheriting of the culture, but also its economic value. For this reason, whether or not regional symbol can give birth to a new economic industry, or undertake the responsibility of making profits, becomes a riddle.

Throughout the development results of regional symbols, the “Frog Pattern” from Hainan Li people’s culture becomes one of the most successful case of industrializing regional symbol. (“Frog Pattern” is the traditional image in Li people’s culture and it is still under usage. “Frog Pattern” shows Li people’s worship to frogs and the mother nature. Now, “Frog Pattern” has melted into their modern arts and designs, and it creates economic value in a way that also creates value for Li people’s regional culture.)

1 Regional Traditional Symbol's Transformation in Cultural Industry

1.1 The City's Orientation and Transformation – Product from Single to Sequential

The regional symbol is the essence of the ethnic art and is first created as the materialized view. Once shown as art designs, the regional symbol and its products are now transforming from single to sequential, as a result of culture gradually replacing traditional industry becoming a rising force.

The regional symbols now, show their traces in clothes and decorations. Mostly, regional symbols have specific meanings, and appear in history and literary works. In old times, regional symbols are widely used in tribes' buildings to distinguish different nations and areas. However, as time goes, with transportation getting more and more convenient, trades between different places become more and more frequently. Little by little, the original intention of the regional symbols changes with the expansion of business. The meanings of regional symbols get ambiguous later, due to the trade and cultural exchanges between areas.

So, it is an inevitable trend that regional symbols turn into a new branch of cultural industry and go into market. In the context of promoting cultural industry, traditional regional symbols, this simplified culture, change the simple pattern into cultural products with a sequence. Meanwhile, this transformation also return regional symbols to their original purpose, representing regional features materially, and back to the use on buildings and city environment.

Now, at the time of the new beginning of cultural industry construction, our attention locates on how to use regional symbols more widely and make them derive varies kinds of products. Needless to say, it is also the most efficient way of protecting traditional patterns.

1.2 Core Revolution – Becoming the Principal Part of Development of the City

It is shown that a city's development and the economy are bound together, under which circumstance, cultural industry is now the new core of cities' development. In other words, regional symbols are proved to be the most representative and simplest schema language to let people have a brief view of the city. At the beginning of the development, "green", "eco-friendly" and "sustainable developing" are the themes of the development, due to serious pollutions caused by industrial production. Cultural industry development now is standing on the shoulder of the "green" giant. Tourist industry, as part of cultural industry, is considered to be the "green" economy creating more job opportunities, in which way, help the economy recovery, pointed by WTO vice executive secretary Lipman on Boao Forum for Asia in 2009.

In the light of this statement, regional symbols as green cultural industry is becoming the new centre of development, and drive the cities starting a new developing journey in an “eco-friendly” way.

2 Regional Symbols Drive Economy

To the development of Chinese cultural industry, deputy director of the Central Propaganda Department and Reform Office Gao Shusheng points out that “The bond among culture, tourism and manufacture is more and more obvious. With the developing of cultural resources, the combination of culture and tourism, which is advanced travel, will show its existence in China. In addition, planting the cultural connotation or element into building materials, which is not only the combination of culture and manufacture, but also has increased the content of culture and products’ value added.” Thus, the industrialized development of regional symbols conforms to the times and the market. The economic value of regional symbols can be seen after it is industrialized.

In the past, the protection of regional symbols is considered money-consuming. With the adjusting of economy structure, tourism, as one of the third industries, becomes a part of the economy structure, especially the distinctive cultural tourist industry. Regional symbols as the feature and summary of local cultures are the most obvious expressions of different areas. So, cultural industry shares part of the economic functions is inevitable in the development of the market. Regional symbols are changing the public’s traditional thinking patterns to tourism, making people accept new type of cultural tourism through building the awareness of different areas to the public. In this way, environmental pressure caused by tourism is relieved.

Below forms and tourist statistic data published by National Tourism Administration are showing the changes of focus of tourist places to people (Zhao Liming and Ren Kai 2009).

Comparison chart of inbound tourist number of 28 regions in 2012 (Fig. 1) Statistics: Inbound tourist number of Shenzhen, Shanghai, Beijing, Guangzhou on top the list.

Comparison chart of growth rate (Fig. 2) Statistics: Wuhan, Shenyang, Chengdu, Chongqing, Tianjin growing fastest.

Chinese Tourism Industry Bulletin (Figs. 3 and 4) Statistics: Inbound tourist number of Guangdong, Zhejiang, Jiangsu, Shanghai on top the list.

Comparison chart of growth rate (Fig. 5) Statistics: Sichuan, Chongqing, Anhui, Gansu, Tianjin growing fastest.

Comparison chart of inbound tourist number of 28 regions in 2010 and 2012 published by National Tourism Administration Statistics: Sichuan, Chongqing, Tianjin etc. increase.

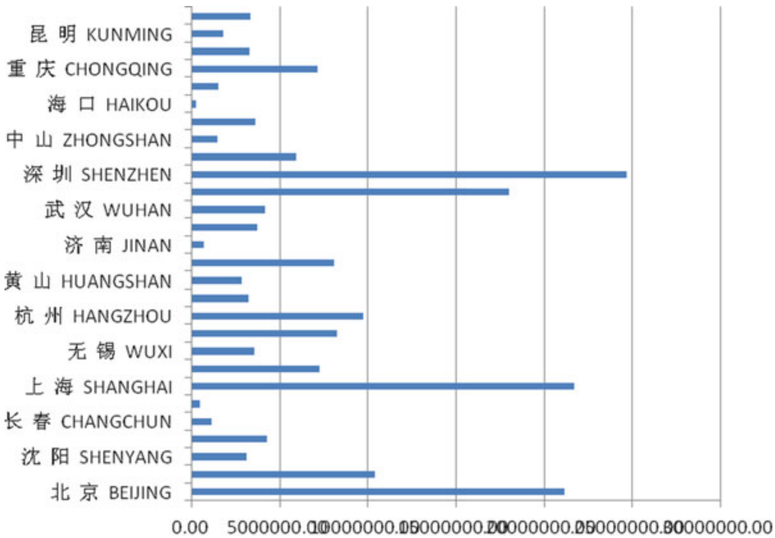

Fig. 1 Comparison chart of inbound tourist number of 28 regions in 2012

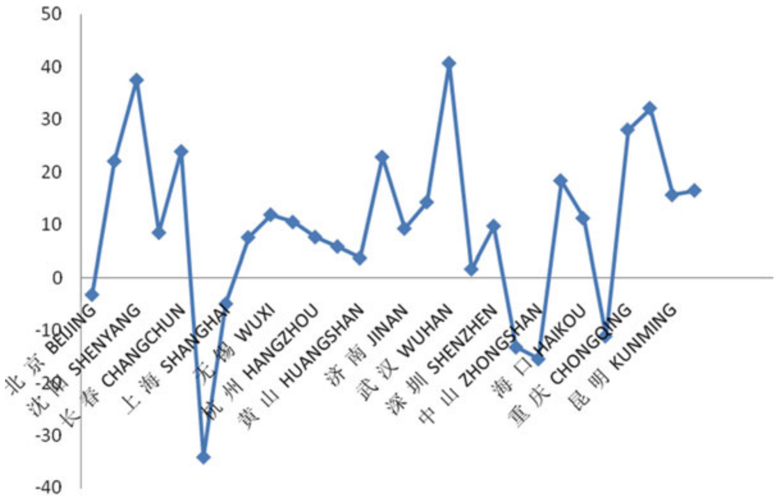

Fig. 2 Comparison chart of growth rate

Above comparison charts can show that recent years, the tourist destinations have changed. The public's tourism is not limited in the traditional way of experiencing the nature any more. Cultural tourism begins to be popular, which means come to a new city, enjoy a new way of life, and understand the most distinctive regional symbol. So, by comparing inbound tourist number in different years and Lorenz curve, we can study the model and analyse the change of public tourist destinations

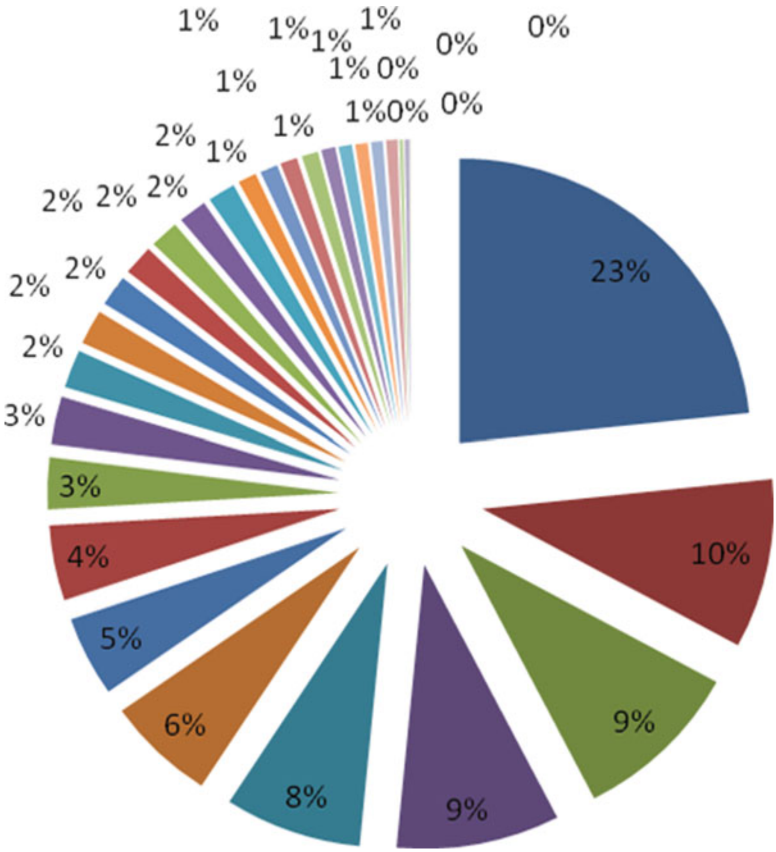

Fig. 3 The growth rate of the number of provincial and municipal tourism, 2011

(Zhao and Cheng 2009). With the analysis, we can prove that regional cultures can undertake the local economic functions. The formula is as below:

$$q_i = \frac{y_i}{x_i} = y_i \sum_{i=1}^{28} x_i \Big/ x_i \sum_{i=1}^{28} y_i$$

In the formula, x_i represents for the total number of the tourism arrivals in the ith area. y_i is the total number of the tourists with a purpose in the ith area. X_i is the ratio of the number of tourism arrivals in the ith area to national total number of tourism arrivals. Y_i is the ratio of number of the tourists with a purpose in the ith area to the national total number of tourists. q_i is the quotient of location of total number of the tourists with a purpose in the ith area. Due to the data of number of the tourism arrivals published by National Tourism Administration is for 28 regions, in the formula, $i \leqq 28$.

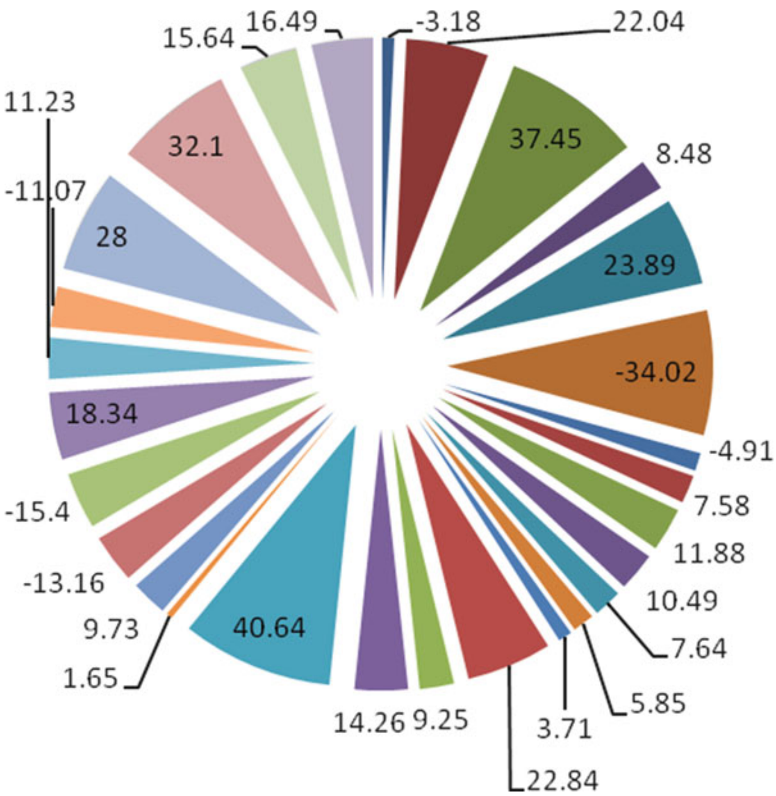

Fig. 4 The growth rate of the number of provincial and municipal tourism, 2012

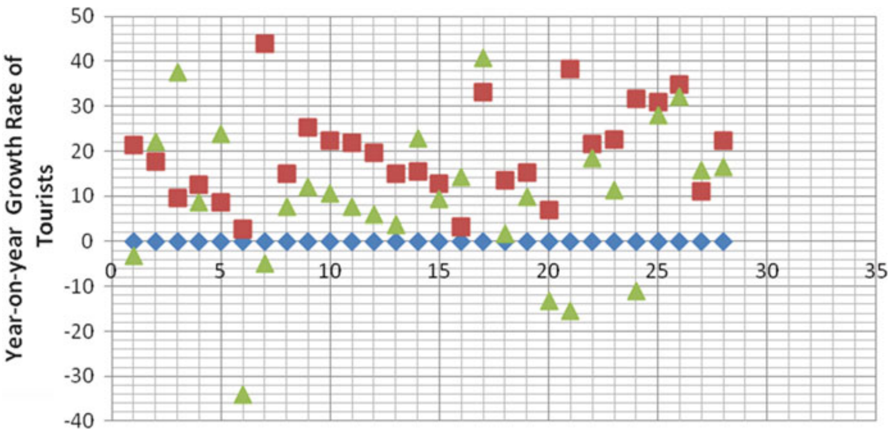

Fig. 5 Distribution of tourism arrivals offset in regions

Through checking the distribution of the tourists, we can draw a conclusion that with the progressive maturation of the cultural industry and the development of local cultures of different areas, for tourist industry, the traditional tourism has transformed into cultural tourism by market demand. Through the data, we can prove the utility of regional cultural products to tourism economy. In short, utmost using of regional symbols will assist the development of regional economy.

3 Transformation of Regional Symbols in Cultural Tourist Industry

As the feature of local cultures, regional symbols are the distillations and the developing regional symbols is directly related to cultural industry, economic benefits and core developing strategy of the city. Yet, how to make these regional symbols attracting people's attention and striking into people's view so that regional symbols can stimulate the development of cultural tourism economy is the difficulty we face at present time (Umberto and Lu 1990).

Cultural tourism is the new tourist product based on cultural resources. The most efficient way of promoting is to enhance people's cognition to the product so that the product can influence people's choices. Analysed from cognitive psychology theories, the principle of it is to record public's attentions, cognitions and memory processes in order to get the original map that is easiest for people to remember. Thus, the transformation of regional symbols can meet the public's expectations (Anderson and Qin 2012).

Experiments show that more than 80 % of the information that one can take is by visual sense. These information makes up the primary memories, as known as the first impressions of all kinds of stimulation, whether draw one's attention or not. This process is the storage of senses, and only stays in short-term memory area. American psychologist G. Sperling did the experiment of remembering three rows of material in 1960 successfully proved the short-term memory. According to the code of short-term memory, men will accept the information provided by the environment and store it temporarily until the information is no longer useful to the brain. For regional symbols' transformation, we need to avoid them stored as short-term memory. By combining regional symbols with different elements, we can strengthen the memories and turn the short-term memories into long-term memories, so that the public can remember the regional symbols, then grow interest to the foreign environment and end up with a cultural tour.

All in all, to optimize the form of regional symbols and build up the regional cultural cognition, there are four suggestions.

3.1 Repeatedly Show and Build Long-Term Memory

Experiments show that men's memories are influenced by the appearing frequency of information. Germen experimental psychologist Hermann Ebbinghaus once record memory through quantificat evaluation, and concluded a formula shown as below.

Saving repetitive-learn percentage = 100 × (number of first-learn time − number of repetitive-learn time)/number of first-learn time

Known from the formula, higher appearing frequency of information can reduce repetitive-learn time, in other words, longer memory.

3.2 Enlarge Visual Image and Stimulate the Conduction of Visual Information

Verficate through vision measurement formula: $\tan\frac{\beta}{2} = S/2D$

S represents for volume of the object, and D is the distance between object and viewpoint. Consolidation is formed when regional symbols become materialized. So, the size of the object helps people to strengthen the spacial learning and memories of regional symbols.

3.3 Tips and Lead Imaginations

This is doable, based on cognitive psychology theories. According to the short-term memory principle elaborated above, we can deduce that when people first see regional symbols, the visual receptor will store the images in short-term memory. Yet, due to the images are with no additional information, and no stimulations are made the brain, the information can be erased. To avoid the brain erasing memories of regional symbols, we have to strengthen the impression to public. English psychologist Bartlett's experiments and pictures can show that people's memories come from the cognitions to things. Human brain has original pattern of all things. That is the reason why brain forgets similar things, just because the ready images are there, so the unknown part is easy to neglect. So, when transforming the regional symbols, the original basic framework needs to be preserved.

3.4 Adjust Color, Tone, and Saturation to Highlight

English scientist Thomas Young and German scientist Hermboltz built up trichromatic theory and opponent-process theory. It shows the process of color code's

Fig. 6 Butterfly

excitement and depression in human's visual cortex. Therefore, we can verify the different affect to human.

Based on the article above, reform sequence of regional symbols can build public cognition. As it is known, most of regional symbol patterns are representational, standing for the complicated and ingenious nature. That is the reason why most regional symbols are curves. As such, regional symbols are too representational to be shown as single symbols and used in building or landscape. They mostly just showed in clothes. In addition, people will feel visual sense distance is limited, due to the similar patterns in regional symbols. So simplifying the patterns can be considered the most important means in updating process.

To sum up, we take the representative butterfly as an example (Fig. 6):

Turn representation into abstraction (use face) – turn arc into tangent lines – break the limited space with dots.

Most of Chinese regional symbols are directly quoted. The complicated pattern is used to decorate in landscape. It is hard to recognize when used in modern design. So simplify traditional patterns and use more dots, line and face are doable.

4 Transformation of Li People's "Frog Pattern"

The reason "Frog Pattern" is chosen as the example is that this pattern is made up by dots and lines and the features of the pattern is clear. So, it is a renovation of successfully transformed pattern. However, when it comes to inheriting the pattern's meaning, the change looks still single.

The study shows that now the "Frog Pattern" is inherited basically rely on decorating Li's brocade (Wang Xing and Zhou Xiaofei 2010). Scholars study

Fig. 7 “Frog Pattern” in a local hotel for example

the pattern on the brocade and include it to research document. Yet the research document is limited because of the conflict between industrial producing and foreign culture. The explanation appears inexact and limited due to the above reason (Qi Qingfu and Ma Xiaojing 2005).

One is the philosophical meaning of “Frog Pattern” on the brocade. The other is the demonstration of five dialects of Ha, Run, Meifu, Sai, and Gou, based on various patterns. The second research shows that there actually exist multiple patterns of “Frog Pattern” (Lin Yihong 2012).

Even though “Frog Pattern” is still single used, it is still a successful case of the transformation of regional symbols.

Take the use of “Frog Pattern” in a local hotel for example (Fig. 7). This hotel has used both representative and abstract frog patterns, to make the public see and relate the frog statue to the abstract image, so that people will get the information of frogs holding significant position in Li people’s culture. This is a start and media of people getting focused on “Frog Pattern” in all areas of Hainan and consuming there. Moreover, the abstract “Frog Pattern” is used in building by practicing the effect of virtual and essence. It is another creative revolution for regional symbols becoming building material.

In conclusion, Hainan Li people's "Frog Pattern" is melted into below factors and makes the transformation a success.

Space factor – by turning representative frog pattern into geometric pattern to add space utilization.
Time factor – turning "Frog Pattern" into a patterning with certain meaning and getting rid of the time limit.
Human factor – providing the public a visual tip to make shape of the cognition.

5 Conclusion

It is very important that how we should transform regional symbols to modern industry in the time of developing cultural industry. Pragmatism philosopher Pierce points out that "The meaning of regional symbols change with the cognition of human. Regional symbols are the expression combining with time, so they can be accepted by people from different fields" (Guo Hong 2004). For this reason, leaving regional symbols in documents, will not only influence their heritage, but also the practical applicability. Regional symbols are updated when they are in use.

In addition, over consuming natural resources will bring us nothing but disasters and seriousness of this problem has been realized, so that people gradually start to develop green economy. However, no cultural industry can leave human factor. To get public's attention and economic benefit, culture should be the focus of development and this is the core of industrial economic development. So, bring the proper information to the public and help the public build the system of regional cultural cognition should be the important move of development.

In conclusion, it is doable to industrialized develop regional symbols under cultural industry, as for regional symbols are easier to be remembered by public, development of tourist economy becomes more important.

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Preliminary Discuss on the University's Bond System About Diligent and Honest

Wei Li and Hui-xin Yu

Abstract Modern independent deposit system is an active mean to prevent official corruption and promote clean government in some developed countries and regions. At present, some local of China has tried Independent deposit system, and achieved a certain effect. For improving the integrity of China's civil service incentive mechanism has certain significance and inspiration. At present, the universities develop quickly, public officers law and discipline violations of university turns upward trend, and implementing the Independent Commission Against deposit system in colleges and universities need for theory and practice investigate.

Keywords Colleges and universities • Independent margin • System

1 Introduction

The honest administration deposit system has existed for a long time. In 1723, the Emperor Yongzheng of the Qing Dynasty implemented meltage fees system to encourage officials' integrity and avoid corruption, so that it named "Honesty" (Zhang Ting 2001). Nowadays, the honest administration deposit also named integrity accumulation fund, honest administration fund and so on. There are different designs and measures depend on different economic and social conditions (Cui 2006). Independent deposit is monthly salary from public officials to extract a certain percentage of salary, units to give a certain percentage of supporting, deposited into a special fund account. If the public officials during his tenure have no corruption and discipline, once full payment of retirement. If there is corruption during his tenure of power, money and other corrupt practices contrary

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to professional ethics in addition to appropriate administrative or legal sanctions, in serious cases, reduce or cancel payment of the amount (Fu and Xie 2005).

With the rapid expansion of the scale of colleges, promotion of the degree of socialize, increasing number of educational resources, diversification of investor and the number of capital flow, especially the management and system lag which bring unprecedented challenges for the construction of honest administration in colleges. Therefore system of prevention corruption is of great significance. Implement the honest administration deposit system should be a helpful attempt of the construction of honest administration based on the experience by developed country.

2 Singapore and Hong Kong Independent Commission Against Deposit System Implementation Overview

By other's faults, wise men correct their own. According to the world Transparency International Corruption Perceptions Index 2011 (CPI) ranking (Corruption Perceptions Index rankings of Transparency International in 2011), Singapore ranked 5, Hong Kong ranked 12, China ranked 75. Therefore, Singapore and Hong Kong's Independent Commission Against deposit system has high reference value (Fig. 1).

2.1 *Independent Deposit System in Singapore*

In 1955 the Singapore government set up the central provident fund system to provide subsistence guarantee for the officials when they are retired. In 1972, the Singapore government will implement a public officer the original pension system to the provident fund system, anti-corruption as a central provident fund deposit system an important part of the management system implemented (Wang et al. 1996).

RANK	COUNTRY	SCORE	REGION RANK	REGION	SOURCES	CONFIDENCE RANGE
1	New Zealand	9.5	1	Asia Pacific	9	9.4 - 9.5
2	Denmark	9.4	1	EU & Western Europe	8	9.3 - 9.5
2	Finland	9.4	1	EU & Western Europe	8	9.3 - 9.5
4	Sweden	9.3	3	EU & Western Europe	9	9.2 - 9.4
5	Singapore	9.2	2	Asia Pacific	12	8.9 - 9.4
6	Norway	9	4	EU & Western Europe	9	8.9 - 9.1
7	Netherlands	8.9	5	EU & Western Europe	9	8.7 - 9.1
8	Australia	8.8	3	Asia Pacific	11	8.6 - 9
8	Switzerland	8.8	6	EU & Western Europe	8	8.4 - 9.1
10	Canada	8.7	1	Americas	9	8.4 - 8.9
11	Luxembourg	8.5	7	EU & Western Europe	8	8.1 - 8.9
12	Hong Kong	8.4	4	Asia Pacific	11	8.1 - 8.7

Fig. 1 Corruption perceptions index rankings of transparency international in 2011

With the economic and social development, Continuous extension of the functions of the Central Provident Fund. In July 1992, the Singapore Government to address the diligent and honest administration of public officers the issue of incentives and constraints, the total fund to pay public officials to further improve the proportion of 40 %. Singapore law, corruption occurs when public officials in the criminal punishment, forfeiture of all fund. Integrity of public officers who, without corruption, bribery, dereliction of duty and other violations after retirement, with the fund family income is sufficient to ensure an affluent life, to live and work. The late 1990s, Singapore is recognized as one of the world's least corrupt countries.

2.2 Hong Kong Independent Commission Against Deposit System

Identify applicable sponsor/s here. *(sponsors)*

Hong Kong and Singapore provident fund system similar to the ideas, but also in the high salary, based on monthly by the government from public officials to deduct a certain percentage of wages, government subsidies by a certain percentage, together constitute the fund. After 2003, the SAR government to adopt a progressive contribution rates by 5 % of basic salary members gradually increased, up to 30 years of service or more 25 %. Hong Kong after the implementation of provident fund system and the pension system than previously, officials still have a great retirement income. Hong Kong Independent Commission Against deposit system as a whole community to play an important role in promoting (Bardhan 1997).

3 The Situation of the Independent Commission Against Deposit System Implemented in the Mainland of China

Since 2000, the Mainland of China one after another, many local governments began the trial with Singapore, Hong Kong's Independent Commission Against similar deposit system, Liuyang City, Hunan Province, is the first pilot implementation of the Independent Commission Against deposit system.

3.1 The Situation of the Independent Commission Against Corruption Margin System in Liuyang Hunan Province

The local government rules that people should sign an agreement with the employer to join the independent commission against corruption margin system which set up the personal special account include personality and collectivity. The personal part is the 10 % of the wages per month by themselves and the collective part is the twice of the personal part by the employer.

In July 2000, Liuyang City first implement the independent commission against corruption margin system in personnel bureau and come up with a series of paper like *The independent commission against corruption margin system in Liuyang*, *The implementation plan of the independent commission against corruption margin system in Liuyang*, *The supplementary agreement of the independent commission against corruption margin system in Liuyang*, which perfected the independent commission against corruption margin system more. Firstly, it clears that all the deputy section-level leading cadres or more must join the independent commission against corruption margin system. Secondly, check the standard of amount which change the standard by wage percentage to scale and the fittings is also the twice of personal part. Thirdly, change the payment. If people have no disciplinary violations during their term of office, they can take it on time and in full when they are retired or leave. But if not, they will take the economic punishment. From 1997 to 2001, the number of officials who were investigated were average 175 per year in Liuyang. Since implement the independent commission against corruption margin system to 2008, there were 107 employers almost 1,416 people join the system and only 28 officials were punished. It shows that the self-discipline consciousness of leading cadres enhances obviously and the rate of violations descends obviously, which makes a good effect (Xu 2004).

3.2 The Situation of the Independent Commission Against Corruption Margin System in Other Mainland

Although the independent commission against corruption margin system has several problem, there are still some local government imitate actively. In late 2002, the Mentougou local tax bureau in Beijing implemented *Interim measure of the diligence of the deposit*; In early 2003, the internal revenue service in Ankang City, local tax bureau in Xuyang and Pucheng county and the Bilin district court in Xi'an City Shanxi Province implemented the independent commission against corruption margin system; In late 2003,the bureau of finance in Pingxiang City Jiangxi Province, the local tax bureau in Chengde and Ningjin county Hebei Province also implement the system; In September 2004, the industrial and commercial bureau in Nanjing ruled that the typical cases of integrity and diligence can get not only the honor but also the reward of 200,000 one-off when they are retired; In January 1st 2005, Zhejiang Province come to implement the pilot of honest administration deposit among officials who can take 300,000 one-off from an official to section chief when he retired; In January 2007, Yuqing County Guizhou Province implement the system; In January 2009, Chengmai County in Henan Province also implement the same system. According to the incomplete statistics there are 25 provinces and parts of local government are trying out the system, which accounts for the validity of 73.53 % (Hong 2005). But there is no same case in colleges.

4 Thinking of the Independent Commission Against Corruption Margin System in Colleges

4.1 The Practical Significance of the Independent Commission Against Corruption Margin System

4.1.1 The Independent Commission Against Corruption Margin System Is the Objective Needs of the Situation

Since reform and opening, China's economic reforms had made a breakthrough, but political reform has lagged behind. That the party's congress, political reform must continue to deepen, to better meet the needs of economic and social development. In the process of structural transformation, anti-corruption system is not perfect, imperfect, and system implementation a number of factors such as poor supervision, resulting in corruption in some areas are more prominent, especially the use of public power to "rent-seeking" crimes issues still generally, from the amount of money involved to the duties involved are constantly on the rise. According to the 2007 Chinese Ministry of Education special survey, universities violation of discipline cases in the education system has been in a high proportion of the total, up 26.4 % (Table 1) in 2005. Independent deposit system is established not only to further improve the clean system, but also the formation of economic corruption, rent seeking both raised the rent side, but also increased the cost of corruption of public officials to resist the legitimate interests of improper revenue, cut off the chain of rent-seeking, reach the source of corrosion (Ni Xing 1997).

4.1.2 Independent Anti-corruption Mechanism Deposit System Is a Necessary Complement and Improve

China's anti-corruption work for many years the practice has been initially explored a number of effective ways to carry out anti-corruption and means, but for a complete system and mechanism, the only reward is the incomplete without punishment Independent deposit system implementation, aimed at creating a new anti-corruption long-term incentive. Margin is used to encourage honest public servants honest life, the reward money in politics, generally one-time payment to be made upon retirement (Becker 1968). The longer the tenure of public officers,

Table 1 Proportion of the total number in the education system in the case of illegal cases in colleges

	Year	Accounted for the cases in the education system (%)
1	2004	20
2	2005	26.4
3	2006	24.5
4	2007	21.3

the higher the position, the greater the amount of clean margin, the greater the cost of corruption, so this is a long-term incentives, is the anti-corruption mechanism to supplement and improve the system.

4.1.3 Independent Deposit System Is a Useful Attempt to Increase the Cost of Corruption

Economics and management in the economic man assumption, the cost – benefits, such as asymmetric information theory for the implementation of the Independent Commission Against deposit system provides a basis for scientific theory (Kaufmann 1997). Corruption from a theoretical point of view is because of information asymmetry and moral hazard arising (Krueger 1974). The most basic way to solve this problem is to strengthen supervision, but need to pay the cost of supervision, and effective supervision of a certain degree of difficulty, high cost. The most basic way to solve this problem is to strengthen supervision, but need to pay the cost of supervision, and effective supervision of a certain degree of difficulty, high cost. From another perspective, people are always rational economic analysis to determine their own behavior, no matter who you are, what kind of work involved, they can not change people the nature as “rational economic man,” (Posner 1975) The deposit system is clean from the economy, from the cost of human behavior on the cut, increase the cost of corruption and discipline to their own trade-offs (Gitelson et al. 2009), change “to clean” to “I want to clean” and thus enhance the university at all levels public officials honest practitioners of consciousness and initiative, to promote the purpose of ensuring clean.

4.2 The Independent Colleges and Universities System Margin of Feasibility Analysis

4.2.1 Colleges and Universities Need a Clean and Harmonious Environment for Development

Today’s world, knowledge for improving the overall strength and core competitiveness of the increasingly important role, innovative economic and social development of the increasingly urgent demand for talent, investment in education and human capital-output ratio of the contribution to economic growth have become increasingly prominent, colleges and universities are playing an basic education, global and leading role in promoting innovation-driven and community into the development of endogenous growth track to achieve the development of scientific development and harmonious development of the first. However, because our economy is undergoing a period of profound changes in the economic system, profound changes in ideas, institutions of higher learning of the resources increased significantly, the

Table 2 Keyareas of risk analysis of independent colleges and universities

Question number	Options	Select the number	The proportion of the total number of accounts selected (%)
A	Infrastructure and service improvement project	1,317 persons	66.55
C	Materials, equipment procurement	1,117 persons	56.44
D	Bidding	909 persons	45.93
E	Entrance examination	701 persons	35.42
B	Financial Management	650 persons	32.84
H	Logistics 'outsourcing' services	566 persons	28.60

rapid expansion of the scale of capital investment, the rising amount of material procurement, enrollment increased, the objective induced contrary to the ethics of corruption in the soil and conditions of gradually increasing. Once the university there law and discipline violations will inevitably result in adverse social impact of the development of the school is bound to bring irreparable loss. Tianjin University in 2010, according to Independent status questionnaire survey (Table 2), corruption of the university easier to focus on areas of infrastructure, procurement, bidding, entrance examination, financial management and logistics management among. Therefore, the university's rapid development is inseparable from the development of healthy and harmonious environment could not leave without advocating clean culture to develop. Independent build and pilot deposit system will help to further promote clean and efficient university-related functions, and promoting public colleges and universities to consciously resist the concept of illegitimate interests and the temptation of corruption, help colleges and universities continue along the track of a harmonious, stable and healthy and rapid development.

4.2.2 The Steady Development of Colleges and Universities for the Implementation of the Independent Commission Against Deposit System Provides a Good Economic Foundation

In recent years, the university gradually expands the scale, gradually increasing revenue streams, development potential and gradually enrich. Tianjin, for example only, according to the "2010 Tianjin education statistics" show, Tianjin University covers an area of 3260.9981 square meters, fixed assets 237,2484 million, Tianjin Education Commission in 2009 to achieve their respective 15 universities total income 417,432.9 million, an increase of 0.6 %, self-financing 1,726,740,100 yuan, 41.4 % of total revenue; achieve education expenses 371,276.45, an increase of

0.7 %. The rapid development of colleges and universities for the implementation of the Independent Commission Against deposit system provides a good economic base. Accordance with the design philosophy, clean margin from wages and government finance officials in two parts, the rapid development of higher education, multi-channel sound momentum of growth in revenue year after year, to ensure a stable source of clean margin. At the same time, the existence of margin integrity, but also conducive to the accumulation of capital accounts and lower personnel expenses, real-time expenditures, capital operation to increase the school's space and ease the pressure of debt run.

4.3 The Independent Colleges and Universities System, the Overall Concept of Margin

Into account the Independent Commission Against deposit system at home and abroad in different parts of practical experience, which should include the scope, funding sources, payment methods, such as content management, and withdraw (Casnio 1998). Considering the actual situation of Tianjin University, made the following overall vision.

1. *The scope:*
   College management cadre pilot. In the course of trial, can continue to deposit on the clean system to supplement and complete.
2. *Sources of funding:*
   Money paid by individuals and financial matching funds of two parts. Deducted from the wages of public officials to pay a certain amount as a base, the proportion of university finance for funds in accordance with the appropriate matching, matching the proportion according to the actual capacity of the unit or to adjust gradually increase.
3. *Payment methods:*
   Monthly payment to be taken way. Monthly payment of a monthly reminder of cadres continue to strengthen their sense of self-discipline in order to better play the role of alarm bells ringing. Specific mode of operation is: every honest public officials to set up a fund account, the monthly withholding, while schools in part by the units, subsidies allocated into the individual Independent fund accounts.
4. *Draw:*
   Margin integrity using public officer resigned after the withdrawal lump sum approach. To establish and improve the integrity margin withdraw the approval process, a public officer nearing retirement, to the relevant department for approval, strict examination and approval department should be reviewed and issued by the relevant credentials, no violations of law of retired public officers in full and on time to receive the Independent Commission Against margin.
5. *The penalty rule:*
   To develop a detailed assessment methods and punishment rules, strict definition of violations of law and the corresponding penalties under the act and strength.

4.4 Against Deposit System Needs Attention

Colleges and universities to implement the Independent Commission Independent deposit system is a new type of corrosion mechanism, still in the exploratory and pilot phase, funding sources, investment ratio, the amount of size and institutional environment and supporting the implementation of systems and many other factors, in order to make the system achieve the desired results, the following question must be given to:

1. *The Independent Commission Against margin financing issue*
   If funding can not be effectively resolved, the Independent Commission Against deposit system useless. According to the current practice of the domestic part of the local government, the main source of public funding of salaries and financial administrative allocation of special funds, but which inevitably encounter from the legal, policy level barriers; In addition, the proportion of wage withholding and financial investment ratio also further analysis demonstrated need to do.
2. *The Independent Commission Against deposit sources of funding of legal issues*
   Some view that no legal basis for the Independent Commission Against deposit system. Because the integrity of the individual part of the deposit is part of a public officer as a deposit payroll deduction, to deduct from the wages do not meet the "Constitution" which states: The state protects the legitimate personal income and private property. This deduct is a violation of legal income. Therefore, it is necessary to learn the relevant systems and regulations of housing fund, to fight top-down government policies and legal dimensions of.
3. *The effect of deposit system integrity and effectiveness*
   Since the available amount of authority and resources, clean margin on ordinary public officials and leading cadres of the binding will be different, the binding of the ordinary public officials relative to the latter will be larger. For leading cadres, its powers and resources to master the richness, may determine its rent-seeking and corruption of the "rent" a much larger, ranging from hundreds of thousands, many tens of millions, even billions, so attempt by tens of thousands, hundreds of thousands of Independent margin to constrain the idea of corruption, the actual results need further examination of practice.
4. *Anti-corruption mechanism deposit system to run*
   Independent deposit system operating mechanism should be further standardized. Independent funds due to local establishment and try not long, no fixed pattern, the specific implementation details vary. Colleges and universities must be closely linked to their actual, honest margin in the development and operation of the system on the ways and means to make scientific and reasonable standards and improve, rather than copying and blind obedience, so as to achieve the desired results.
5. *Independent regulatory and safety margin*
   Independent safety margin preservation and appreciation of regulatory measures should be further strengthened. Independent deposit system is a long-term man-

agement process, with time, accumulate more margin integrity, how to strengthen the integrity margin supervision, management, and to avoid financial risks, and ensure that the appreciation of honest margin preservation, study and solve the current should be a major issue. Should learn from the housing provident fund management approach to management of the Independent Commission Against deposit to ensure the integrity of security deposit funds and increasing the value.

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The Influence of Consumers' Need for Uniqueness on Perceived Value and Purchase Intention

Jun-feng Liao, Hua-qiong Chen, and Pei-er Cai

Abstract This study proposes a conceptual framework that utilizes consumers' need for uniqueness to explain the link between product variety and purchase intention. The results of the empirical study show that product variety mediated by perceived value and need for uniqueness has significant positive effect on attitude, and mediated by need for uniqueness affect positively perceived value. Meanwhile, attitude can effectively convey the influence that perceived value and need for uniqueness impact on purchase intention.

Keywords Attitude • Need for uniqueness • Perceived value

1 Introduction

In recent years, much attention has been paid by customers to product variety. Jonah Berger's study shows that consumers tend to make a choice from the sellers who can provide more options; Barbara pointed out that product variety is proportional to the consumers' positive feelings about products, which brings a more enjoyable experience to better meet the needs of consumers (Kahn and Wansink 2004). The Alvin, et al. studies have shown that product variety mediated by perceived quality has significant positive effect on brand choice, and mediated by perceived expertise affect positively perceived quality (Guoying Wu and Qingfeng Hou 2009).

But there are also some experts raise questions about those studies. Iyengar and Lepper hold the view that, in the face of more production to choose, on the one hand consumers will like the selection process, yet on the other hand they will feel

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more difficult to make a choice, and may give up to buy (Iyengar and Lepper 2000). Furthermore, diversification of products and even customized ones will increase the cost of the enterprise to a certain extent. However, Franke found that consumers are willing to own their customized products with higher purchase intentions and higher additional price compared to the better standard of technical quality watch (Franke and Piller 2003).

So, these contradictions raised a question that should the enterprises place a higher priority on product variety (including customization) as an important means of competition to cater to consumers' growing need for uniqueness? Therefore, this article is to study the path of product variety impact on purchase intention and how the need for uniqueness plays a regulatory role in the path of influence.

2 Study Significance

According to previous reference, most of them concentrated on perceived value and factors which affect purchase intention, seldom on the need for uniqueness. Less attention has been paid to the study combining relationship of product variety and need for uniqueness. It's difficult for sellers to make a balance between the increasing cost of product variety and the higher profits form higher purchase intention.

Thus, this study tries to find out the role that the need for uniqueness plays in the process of choosing various products through the empirical research, so as to provide suggestions for merchants.

3 Literature Review

3.1 Product Variety

Fisher (1999) defined product variety as the width of products provided by the enterprise and the rate of new products to replace the old ones (Fisher et al. 1999). Martin and Ishii (1996), basing on Fisher's view, divided the variety into spatial variety and generational variety, the former refers to the diversity of product which enterprise can provide in a certain time, the latter refers to the diversity of products of different generations in the future (Martin and Ishii 1996). In this study, combined with Martin's view of "spatial variety" and the needs of this study, product variety is defined as a choice space which is created by different styles or types of products in an enterprise, including the categories designed with customers' participation.

3.2 Need for Uniqueness

The concept of consumers' needs for uniqueness comes from the Snyder and Fromkin (1977)'s unique theory. They believe that the individual needs to comply with the popular social norms in order to avoid conflicts and win recognition, approval and reward of the others, but everyone has to reflect the personality desire and pursuit of difference (Snyder and Fromkin 1977). Lynn and Harris (1998) research has shown that consumers tend to buy unique products consciously to form self-intention which is distinguish from others (Lynn and Harris 1998).

3.3 Perceived Value

The concept of perceived value can be roughly divided into three categories: "pros and cons", "multi-factor" and "comprehensive evaluation". Sweeney and Soutar (2001) simplified the theory of "multi-factor" and developed the PERVSL model, in which the customer value is separated into emotional value, social value, quality and price. Babin and Darden (1994) explained the motivation for purchase from the aspect of practical interest and pleasure interest. This article draws on Mingli Zhang et al. (2012), measuring customer perceived value by two dimensions of the practical value and hedonic value.

3.4 Consumer Attitudes

The so-called attitude is one's long-term evaluation, feelings and the resulting action about certain things or ideas. Attitude can make people adopt consistent action to similar things (Guoqing Guo 2003). The ABC model and Fishbein multi-attribute model are general recognized in the studies of attitude. ABC model considered that the attitude includes three elements: feelings, behavior and cognition. The model advocated "consumers are fully thinking about future actions." Fishbein's multi-attribute model is a compensation model of product attribute, which is to mean the consumers' attitude is determined by the sum of all the properties on products. Based on Fishbein, Bonfield viewed attitude as the sum of the factors that bring motivation of consumption (Bonfield 1947).

3.5 Purchase Intention

According to Fishbein (1975) (Sweeney and Soutar 2001), intention is the subjective probability of the individual to engage in a particular behavior, and the purchase intention is the subjective probability of consumers in specific purchasing behavior. Purchase intention, by extending the same concept, is the level of subjective probability that consumers are willing to take a particular behavior or the possibility of consumers trying to buy a product or judgments about how individuals plan to buy a particular brand (Kahn and Wansink 2004). Consumers' decision-making depends on their purchase intention.

4 Research Design

4.1 Variables Select

This study is to use SEM in quantitative study. Basing on previous researches and combining many studies, this theme is to set five variables as follow: product variety, need for uniqueness, perceived value, attitude, purchase intention.

4.2 Product Variety

Product variety refers to a choice space of different styles or types of products provided by merchants.

4.3 Need for Uniqueness

Consumers need for uniqueness is defined as an individual pursuit of differentness relative to others.

4.4 Perceived Value

The concept of perceived value is the practical and hedonic value that can be felt by the customers.

4.5 Consumer Attitudes

Consumers' attitude to products is the way that they think and feel about it.

4.6 Purchase Intention

Purchase intention is the level of probability that consumers are willing to buy products.

5 Questionnaire and Model Design

5.1 Introduction

This questionnaire is a scale questionnaire using Likert Scales to detect the investigators' feelings about the five variables. Product variety indexes came from the study of Young Ah Kim and Kelly; Need for uniqueness section has been combined with Tian and Lynn's research and the simulation in this study; Indexes of perceived value came from the study of Parasuraman and Zeitha; Purchase intention section is according to the study of Zeithaml.

Questionnaires simulate a real scene, which allow respondents to imagine themselves shopping in an online sports shoe store, where customers can choose whether to participate in the design of the shoes. This study, with reference to Lou Zun (2010), selects sports shoes as experimental stimuli since everyone is familiar with the product. The diverse nature of shoes is easily expressed. Meanwhile, the pursuit of individual customized sneakers meets the taste of the youth thus reflects the young consumers' pursuit of unique products to some extent (Zun Lou 2010).

5.2 Hypothesizes

Product diversity can convey product information to Consumers, which influences their judgment. This theme sets:

H1: PVR and PVL are positive correlation;
H2: PVR and NU are positive correlation;
H3: NU and PVL are positive correlation;

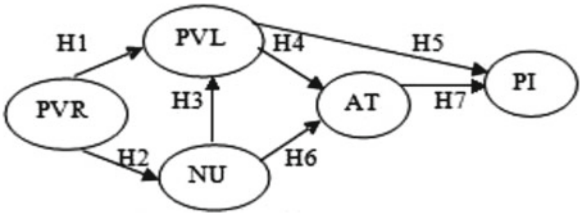
The importance of perceived value is that it has a direct impact on consumers' attitudes and purchase intention. This theme sets:

H4: PVL and AT are positive correlation;
H5: PVL and PI are positive correlation;

One's attitude may be affected by his unique need. This theme sets:

H6: NU and AT are positive correlation;

Fig. 1 Research model



PVR: product variety; PVL: perceived value; NU: needs for uniqueness; AT : attitude; PI: purchase intention.

Both ABC model and multi-attribute model has established a link between attitude and purchase intention. This theme sets:

H7: AT and PI are positive correlation.

Conceptual model constructed in this study is shown in Fig. 1.

6 Investigation Design

6.1 Tentative Investigation

Initial questionnaire has been finished based on previous study and opinion by concerned experts. Questionnaires were sent to students of Bachelor degree and Master degree in Guangzhou, Xiamen and SCUT. 122 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.

6.2 Formal Investigation

Formal investigation is sampling survey in college and commercial district in Beijing, Fujian, Guangzhou, Guizhou, Hangzhou, Heilongjiang and Shanxi. 350 questionnaires have been sent and 329 were recycled with 94 % recovery rate. 316 of them are effective. Ineffective questionnaire index contains: unfinished, or more than one wrong answer in all the three questions. Any questionnaire which meets one of the situations above will be considered as an ineffective one.

Table 1 Reliability and validity

Latent variable	Q	Mean	S.D.	F.L.	C's α	KMO
Product variety	Q31	5.2223	1.41484	0.841	0.926	0.717
	Q32	5.3971	1.35397	0.801		
	Q33	5.1143	1.35781	0.704		
Unique needs	Q41	5.08	1.39356	0.724	0.866	0.717
	Q42	5.14	1.30036	0.763		
	Q43	4.7829	1.44577	0.793		
Perceived value	Q51	4.9429	1.29674	0.758	0.839	0.807
	Q52	4.9486	1.21721	0.816		
	Q53	4.8286	1.26187	0.705		
	Q54	5.1032	1.2321	0.642		
Attitude	Q61	5.1257	1.30591	0.6	0.866	0.789
	Q62	5.1371	1.2547	0.704		
	Q63	5.0229	1.19432	0.713		
	Q64	4.8343	1.19501	0.535		
Purchase intention	Q71	5.0543	1.30238	0.708	0.845	0.823
	Q72	4.9343	1.17213	0.72		
	Q73	5.0314	1.16621	0.777		
	Q74	5.0257	1.21213	0.776		

6.3 Reliability and Validity

Basing on the reliability and validity analysis with SPSS 16.0, Table 1 shows that Cronbachps α is between 0.839 and 0.926. The entire Cronbachps α is 0.926, so that the questionnaires have a good reliability and reasonable design. This theme used SPSS 16.0 to analyze the reliability of samples. The result is as follow: KMO is among 0.717–0.823 and the entire KMO has reached 0.931. 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.

6.4 Structural Equation Model Testing

This theme use AMOS 17.0 to test the hypothesis. As Table 2 shows, the result of AFI, IFI and PFI are all match up to index. It shows that the model has good fitting effect and can do the following analysis.

6.5 Path Analysis

The path relationships in structural equation model are displayed mainly by standardized regressive coefficient. The higher the number is, the more importance

Table 2 Results of SEM testing

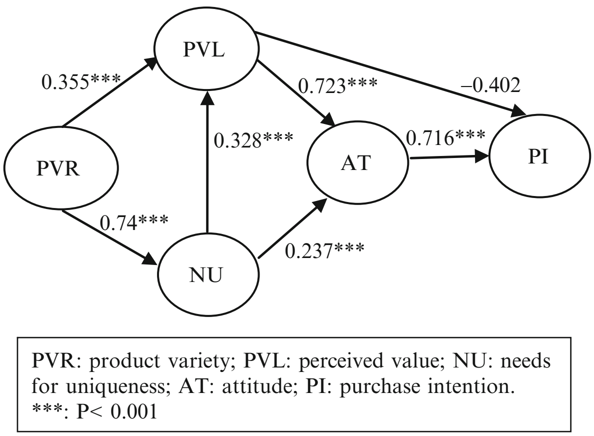
	Model fit standard	Ideal result	Model	Degree of compliance
AFI	X^2/df	<5.00	2.001	Yes
	RMSEA	<0.08	0.059	Yes
	GFI	>0.90	0.914	Yes
	AGFI	>0.80	0.88	Yes
IFI	NFI	>0.90	0.927	Yes
	CFI	>0.90	0.962	Yes
	IFI	>0.90	0.962	Yes
	RFI	>0.90	0.908	Yes
PFI	PNFI	>0.50	0.739	Yes
	PGFI	>0.50	0.652	Yes
	PCFI	>0.50	0.767	Yes

Table 3 Results of structural models

Paths	Hypothesis	Estimate	Results
PVR->PVL	H1	0.355***	Support
PVR->UN	H2	0.74***	Support
NU->PVL	H3	0.328***	Support
PVL->AT	H4	0.723***	Support
PVL->PI	H5	−0.402	Nonsupport
NU->AT	H6	0.237***	Support
AT->PI	H7	0.716***	Support

***$P < 0.001$

Fig. 2 Test results of structural models for supposing the relationship



it gets. As Table 3 shows, in those 7 hypotheses, 6 of them are supported for they are in significant level, but H5 is refused for not being significant.

The completely standardized path coefficient of the affected factors is shown in Fig. 2.

7 Conclusion and Suggestion

According to the testing models, the conclusions have confirmed most of hypothesized. But H5 did not for it did not reach significance level. Different from previous study, for instance, Guoying Wu et al., whose study mainly concentrated on the effect from perceived value to purchase intention, but this theme supposed the fully mediated role attitude plays between the link of perceived value to purchase intention. The reason will possibly be that most of investigators have placed a priority on their own subjective attitude subconsciously before their motivation of consumption created.

The significance and path coefficient of H4, H6 and H7 are outstanding. It means attitude can effectively convey the influence that perceived value and need for uniqueness impact on purchase intention. So merchants must pay more attention on the generation and changes of customers' attitude, especially the passive attitude. Merchants must polish up their products and service to approach the better attitude.

In all supported hypothesis, H2 is highest in significance and path coefficient. We found that merchants should set the group of people who have high need for uniqueness as first targets, since they will be willing to pay more for their fancy which can bring more profit. Significance and path coefficient of H3 and H1 are also outstanding. Therefore, how to meet the unique need of consumers to increase their perceived value is also a main subject of promotion.

H6 is significant, even not in a high level. It shows that though consumers' attitude is impacted by perceived value in a large part, need for uniqueness is in play as well. That is to mean, individualization and diversification products or service is required to meet the growing need.

The conclusion of model testing has proved that need for uniqueness has certain effect in the path of product variety impact on purchase intention, especially for the one who possess high unique need. Consequently it is a obvious signal for the merchants that enrich the intension of product variety by methods which catering to customers' taste.

In today's society, merchants can encourage customer to participate in the design of product or service via the internet. Besides, they should build up the database where stores the details about every customer, then use the technology of data mining to analyze individual needs thus a better strategy can be made out in the face of segmentation market competition.

In a word, the choices of consumers decide the profit. Taking buyers' unique needs as a priority is a necessary strategy. Meanwhile, for perceived value and attitude have very close relationship, maintaining perceived value also cannot be ignored.

8 Limitation and Future Directions

This theme finds out the significant impact that need for uniqueness has on purchase intention. But there are still several disadvantages, like just doing research in a simulation for only one kind of products. The results may vary from researches about different kinds of goods. Future study will across types of goods to make more convincing and comprehensive conclusions.

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Study of “Co-opetition” Strategy in Nonlinear Environment

Zhen-hua Li and Min-ru Zhao

Abstract In the nonlinear environment, co-opetition strategy has become the main approach for modern enterprise to gain competitive advantages. Based on the analysis of new tendency of the enterprise strategy’s evolvement from antagonism to co-opetition, then the reason why co-opetition strategy occur and exist widely with the use of correlative theory is given, at last the influence of co-opetition on the traditional strategy pattern is described. The study shows that, taking the co-opetition strategy has great significance of enterprises for a profound longterm development.

Keywords Co-opetition • Nonlinear environment • Strategy • Value network

In the twenty-first century, with the accelerated globalization of the world economic development, the strengthening of the trend of integration and scientific and technological progress speed, the process and the way of the economic operation has fundamental change, further enhancement of the competitive environment of uncertainty and complexity. Undermine competitive advantage brought by the tradition of internal resource integration, insteadly, enterprises and customers, suppliers and other relevant interest groups increasingly close interaction and mutual influence. In this context, it has been very difficult to maintain a long-term competitive advantage on its own strength. In order to compensate for the limitations of their own resources and capabilities, enterprises must join with other enterprises and co-opetition has become the main way of modern enterprises to gain competitive advantages (Nalebuff and Brandenbuger 1996; Brown and Eisenhardt 2001; Hui-hong Liu et al. 2005; Dan-an Xue 2011).

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1 Confrontational Competitive Strategy to the Evolution of Co-opetition Strategy in the Nonlinear Environment

There is a big difference of the enterprise value creation model between under the premise of nonlinear assumption and the traditional linear assumption, as shown in Table 1.

2 Theoretical Explanation of Generated and Widespread Theory of Co-opetition Strategy

2.1 Based on the Interpretation of the Transaction Cost Theory

The transaction cost theory is that enterprise efficiency-oriented management tool and this tool is beneficial for transactions between economic entities, this view is very different from the view with neoclassical economics that emphasized production function and that the efficiency of production only close related to capital and labor inputs (Leiblein 2003). Williamson believed that the difference in characteristics of the transaction lead to different types of organizations, only those that match the organization with a particular transaction is the efficiency of

Table 1 Contrast of the enterprise value creation model under different assumption premise

	The premise of linear assumption	The premise of nonlinear assumption
Form of business competition	Mainly occur in single enterprise	Mainly occur between different enterprise groups
On the value of the pursuit of goals	Short-term and reaction formula	Long-term and dynamic
On the value of the pursuit of manners	Add value	Create value
Value flowing form	Mainly the form of kind	Mainly the form of in-kind
Manifestations of value	Mainly tangible value	Mainly intangible value
The foundation of enterprise competitive strategy	now customer demand	Future customer demand
Value of the background	Traditional industrial economy	Modern information and network economy
The scope of the information Integration	Enterprise value of the internal processes	Value stream of entire value network
Dependence on IT	Weak	Strong
Competition among enterprises	Confronting Competition	Co-opetition
The source of Increase in the value	Mainly within a single enterprise value activities	Mainly the value of activities between enterprises

the organization. He combined economics and organization theory, a large number of staggered the contract law, providing a new perspective for the organization analysis, and showed a strong vitality about the analysis of the generation of business organization, difference and integration. The transaction cost economics has become the core of the organization economics theory (Williamson 1985, 1996).

In the competitive environment with the degree of scarcity of resources today to improve, the co-opetition way can expand the range of enterprises' available resources and be able to overcome the uncertainty of market transactions, significantly reduce transaction costs. Cooperation between enterprises, is often more efficient than too much emphasis on competition, such cooperative arrangements in many cases superior to the internal organization and pure market transaction, is regarded as a way to enhance business advantage which is same to competitive strategy (Wei-guo Zhang and Xue-mei Qinf 2012). Therefore, the co-opetition enables groups within the enterprise to get a lowest-cost institutional arrangement, which is the source of enterprise vitality and innovative spirit, is also a foundation to contend with groups outside.

2.2 Based on the Interpretation of the Value Chain and Value Network Theory

As the market competition becomes more intense, the enterprise is more and more do not rely on a single factor to obtain competitive advantage. Michael porter, who first put forward the concept of value chain, thinks that the company's competitive advantage is based on low cost or differentiation, and resources are configured in the value chain (Porter 1998). British Peter Hines who developed porter's theory, thinks that the competitive strategy is to integrate the value chain of each economic subject ability, restructure the economy main body of skills and resources, so as to adapt to the uncertainty of environment change (Hines 1998). Along with the development of information technology, Jeffrey f. Rayport and John j. Sviokla put forward the point view of the development of the virtual value chain and argued that enterprise should use advanced information communication relations to restructure the location of each link and the character, to make them consistent, so as to adapt to the environment and realize the complementary advantages (Rayport and Sviokla 1995). Adrian Slywotzky in his book *Profit Area*, first put forward the concept of value network, thinks that value network is the network which relies on electronic information technology to connect the related but independent enterprises which are on value creation links. Its main function is through the sharing of information resources to realize complementary advantages and rapid response to market changes. From value chain to value network, people awareness of the value creation form step by step (Yi-fei Du and Shi-ming Li 2004).

With the development of value network, creating enterprise value range has been expanded. Value network gives the related interest groups access to enterprise resources, and through the network of interactions between different levels and

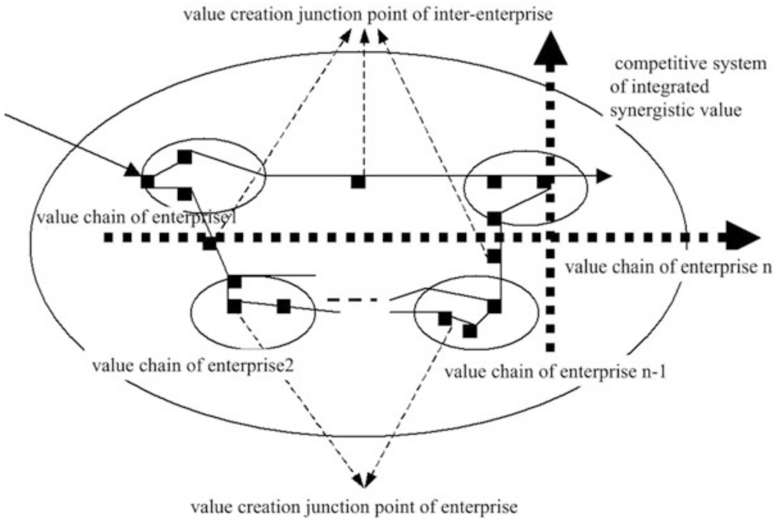

Fig. 1 The enterprise interactions of the value network model

different subjects, multiple value chain can be formed in multiple link network connection and exchange relations. When the cross correlation between participants, the value network will produce network effects, and enterprises or organizations at each network node can get more value. The basic model of the value network is shown in Fig. 1.

Figure 1 shows that the value network has complex value chains, which contain the junction point of the value that connected to different enterprises. The competition between enterprises, more performance for the value chain system, i.e., the competition between the value chain group competition. In the value chain group competition, competitive advantage depends not only on the production management level of a single enterprise, but also on the information network construction and application of efficiency between enterprise in whole chain, depending on the close degree of each enterprise cooperation relationship between the network (Qiang-shen An and Shou-feng Zhang 2006). Therefore, in the value network mode, the relationship between the enterprise in essence is a kind of co-opetition relations, value network is the basis of co-opetition strategy.

2.3 Based on the Interpretation of the Competitive Advantage Theory

The interactive evolution appears in the enterprises competing behavior, whose fundamental motivation is thirst for competitive advantage (Jian-feng Luo 2012). As the representative, Potter's specialized research on competitive advantage theory in industry structure is the earliest, the basic paradigm is SCP (structure – conduct – performance), which means the outstanding achievement of enterprises in the market mainly depends on the industry environment (Porter 1998). With the change in the social-economic environment, a lot of new business models take parts in business manage practice, such as virtual organizations, strategic alliances, supply chain, industry cluster and so on. Jeffery H. Dyer and Harbir Singh made the groundbreaking definition about relationships rent are as followed: just as the above average returns, which from the manufacturers of each other in the exchange relationship, not to complete in a single vendor, but have to make joint efforts to create specific alliance partners. The special relationship between the manufacturers is the source of the relationship rent and competitive advantage. Some important resources can expand the vendors boundary, these resources may be embedded in the resources and practices between manufacturers proprietary assets, such as relations with complementary scarce resources or capability, common learning and exchange of knowledge, or more effective governance mechanism (Dyer and Singh 1998). The theory of "relationship rent" can explain the source of the continuous development collaborative competition in the form of competitive advantage very well.

3 Effect of Co-opetition Strategy to Traditional Strategy Model

In recent years, the enterprises in developed countries has been widely used the theory about global resource integration, strategic alliance, virtual organization, the cooperation of supply chain and industrial cluster to guide the enterprises' practice activities, and achieved great success. A study of Dyer, Kale and Singh showed that, in the world 500 enterprises, each average have 60 main cooperation agreements (Dyer et al. 2001). Dunning thought, strategic cooperation is even far beyond the level of the company. According to his statement, the whole economic system is in the process from "market capitalism" to "transition alliance capitalism", which is the performance of large-scale multinational corporations and small and medium-sized companies form a dense network of interaction through cooperation, and embodies the great synergies (Dunning 1997). Experience in two aspects of the theory and practice show that the difference of competitive strategy between twenty-first century and twentieth century is fundamental, one of the most important aspects is the "interdependent network business" gradually instead of just "vertical integration of enterprises". As a new strategic paradigm, the co-opetition lead to traditional enterprise strategic pattern a fundamental change, mainly in:

3.1 Extend of the Strategy Space in Making the Enterprise Competition Strategy

Under the paradigm of co-opetition, it's becoming more and more fuzzy that the boundaries of industry and enterprise, the enterprise competition strategy plan will no longer be confined to against established in the industry for market share, product or service competition, but more to do in the boundless business opportunities within the scope of the race. The concept of market competition will break through the limit of individual enterprise and be defined in different enterprise groups, which will greatly increase the market competition intense degree and complexity; the market competition of physical space is also being expanded the area all around the world. As the market competition is beyond the scope of a particular geographic region or industry boundaries, and break through the limitation of individual enterprise, therefore, a single enterprise must make competition strategy from a global perspective and cross-industry Angle, and fully consider its own resources and advantages to relate partners and combine them organically, so as to get the best strategic integration effect.

3.2 Increase of Elasticity in Making the Enterprise Competition Strategy

Strategic elasticity is the resilience that enterprise based on their own system for uncertainty environment. It mainly includes the production capacity and production technology of the elastic, marketing elastic, management of the elastic and personnel structure of the elastic, organization learning ability of the elastic and so on. In the co-opetition strategic paradigm, with the development of strategy formulation space, the elastic of enterprise strategy formulation also continuously improve. This is because, co-opetition promotes the flow of the elements between enterprises, provides more can useful resources for a single enterprise, which makes the original single enterprise can't complete some strategic idea come true, such as joint research and development provides the fund and channel for the enterprise products and technology development, joint marketing enhance the competition strategy to revenge resistance of a single enterprise and so on.

3.3 Addition of Scalability in Pursuing the Strategic Target

In the co-opetition strategic paradigm, the enterprise's winning means are constantly changing, from the past simply search for scarce resources to gradually transform into intelligence and scarce knowledge search. The range is no longer limited to internal enterprise boundary, but focus on the outside wide world. Enterprise's consideration in the process of making strategic target is no longer considering their own mutual matching resources, but more to the pursuit of the goal of establish scalability. The enterprise competition strategy from opposability competition to the evolution of co-opetition, provides the basis of existence and the possibility of success for enterprise to pursuit expanding target strategic idea.

3.4 Changes in the Range of the Object of Study of the Enterprises’ Competitiveness

With the evolution of the competitive strategy, the manner of enterprises to participate in the competition has a huge transformation, from a single enterprise into a strategic alliance, enterprise clusters, enterprise ecosystem. The subject of future business activities is a group which with one or more enterprises as the core, that the future of business competition is competition between different enterprises group. Therefore, the study of the enterprises’ competitiveness are no longer limited to a single enterprise, but are expanded to enterprises and enterprises in which enterprise systems or corporate collection.

4 Results

In the new economic environment, enterprises operating independently of traditional pattern is broken, the co-opetition has become the main way for enterprises to gain competitive advantages. This paper analyzes the inevitable trend of enterprise competitive strategy in nonlinear environment from confrontational competition to co-opetition, then the reason why co-opetition strategy occur and exist widely with the use of correlative theory is given, at last the influence of co-opetition on the traditional strategy pattern is described. In this article, the Investigation on co-opetition strategy is still preliminary, a lot of work remains to be further deepened. I believe that based on this paper the following aspects worthy of further study, including: the study of the theoretical system and structural framework of co-opetition strategy, the in-depth analysis of the mechanisms of cooperation and competition between enterprises, research on co-opetition partner selection and evaluation of co-opetition effects.

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The Managerial Modes of Traceable Markets and Application Based on Cloud Computing

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Abstract The managerial modes of traceable markets include the model of service and the methods of technological integration. It has much innovation in the aspects of system structure, system integration and system implementation and so on. In this mode, the managerial markets systems set up in commercial cloud platform integrated quality traceability system, the price monitoring system, intelligent decision support systems and other functional subsystems, through the methods of system integrators and cloud. It can achieve rapid information query, optimization, integration and sharing of resources. The applications of this mode have brought stakeholders (such as direct management departments, Commerce Commission, operators and consumers) for sustainable economic and social benefits.

Keywords Cloud computing • Margins • Traceability

1 Introduction

Primarily based on management systems integration and cloud computing technology, traceable markets achieved intelligent decision support engineering (Jian 2012), quality traceability, price monitoring systems, functions, optimization of resources integration and sharing (Wang Li-qiong 2009), providing people with

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more convenient and comfortable shopping environment, and strengthening markets administrations rapid response capability (Jian 2012), which bringing remarkable economic and social benefits.

1.1 Vegetable Market Management System and Intelligent Decision Support

The main vegetable market management system accessible open application, and through a reasonable billing system, saving the cost of regulatory services and take advantage of the system resource pool, enhancing the efficiency and quality of service management. Based on data access interface and cloud storage, establishing a unified user data center markets simplified network to decouple data on POS machines and other terminals, markets management of business data and other data. And through the distributed file system, accomplishing management of business data's store and access from structured and unstructured markets. Through the platform operators and service bus, etc., the entire distributed platforms as a service provided to the grocer application developers, and its use of Java (JDBC) and other languages or tools needed to develop embedded software solutions markets, achieving food market statistics functions, improving the intelligence level of the system. Statistical functions include three: (1) Goods entering statistics: Select CPI (consumer index) classification established eight categories major product categories, statistics on the supply of products to be monitored. (2) Commodity trading statistics: Statistical fluctuations of the main trends in trading volume products (rice, flour and other major product term trading volume (kg)) as the basis for market demand analysis. As well as the date of the transaction price comparison major products (such as second-class rice, standard flour, pork, etc.) for the price of the farms and the city's lowest price and the contrast between the city's highest price) in order to reflect the market supply. (3) Dealers transactions: The business user's daily settlement of transactions amounted to y value to calculate the trend of business household's transaction amount.

1.2 Search Engine Management System Summary

Standardization of markets integrated query system includes product traceability, price trends, blacklist, transaction inquiries, information interaction, consumer guide, market introduction, business regulation, news feeds. Users can use the above markets kiosk terminal functions. In addition, users can also access a terminal embedded software development cloud services, the access port can access the software as a service layer has an integrated system interface, access to each subsystem and its data.

2 Vegetable Market Management System Functionality

Standardization of markets management system mainly consists of the following nine sub-systems: quality traceability system, the price monitoring system, supply security and emergency systems, payment systems, card systems, Commerce Commission monitoring systems, authentication systems, security systems, cloud computing resource pool and its DBMS.

1. *The quality of retrospective subsystem* (Yang Xinting et al. 2008)
   Product traceability information query function allows the user to enter information traceability of food traceability code. Product traceability and operators of file integrity check feature enables product traceability information query, commodity source queries, business license inquiries, and business households' reputation information query. For example, pork products, which can be traced through the system, you can check each batch of pork products to the country of origin, farm, breeder, the environment, feed, immunization, slaughterhouses, slaughter time, inspection card number, inspectors, supermarkets, grade, preservation, salesperson information (Liu Chuanju and iron Fung Lin 2009).
2. *The price monitoring system functions and operation*
   Vegetable market price query management subsystem main product price information function to view the product price, price acquisition time, whether the warning and price information (Zhang Hong-yan et al. 2006). Price controls, including the main product price information, the main product price trends, the main product prices early warning, the market supply statistics, base supply statistical five sub-functions.
3. *System integration and system implementation*
   Binhai New Area by the commercial cloud server access, the use of B/S system, virtual memory, embedded software and other technology, markets an integrated management system equipment system integration and application integration (Lai 2011). Includes an application program interface (API) integrated interface (portal) integrated workflow integration three levels. Underlying markets complete systems integration seamless integration with heterogeneous database access, integrated subsystems to the same cloud platform and management system for file transfer markets, approving support of business process-based integration.
4. *Service Resource Management and monitoring*
   Read the column using optimized data storage management paradigm, the data read operation to meet the system frequency is greater than the data update frequency. Unified monitoring and management of SMS pricing information markets, markets, bank card payments and other configurations, documentation, permissions and other information, and the process of the formation of markets combined with its associated management system product data management (PDM).

3 Financial Payment Cloud Service

Smart payment card cloud services platform is a set of user information systems, card service system, the card center management system, accounting system, clearing and settlement systems, peripheral cards and card security system in one, covering data acquisition card, card, collection card, report the loss, complement withdrawal card cards throughout the life cycle of an integrated solution.

3.1 Traceable Service Processes of Management and Control

In traditional business models of the markets, operating households delayed payment of wholesalers. In the case of low liquidity, Wholesalers may buy counterfeit products to reduce procurement costs for own profit. Markets operated as a basis for livelihood security, a vicious cycle can also affect the government's image.

However, in a cloud-based markets settlement mode, Wholesalers sell vegetables, meat and other products to dealers, then get a joint bill from households and markets because Wholesalers cooperate with banks, Bank pay the bill immediately and charge merchants a percentage of fee. This process Improve cash flow rate of wholesalers. The fee as part of business households of return attract dealers and other businesses involved in innovation BPaaS, a part as the profits of bank loans. Because the markets are government guaranteed fixed assets and purchases' and sales' system of the market runs on commercial cloud platforms, it can enhanced controllability risks of the banks.

3.2 Design of Service System

Construction of smart payment card on cloud service platform uses SOA architecture based on cloud computing model (Krafzig et al. 2004). SOA makes the card application to get rid of the shackles of technology-oriented solutions and easily respond to changes, Innovation and the law of demand in service. Cloud computing technology enables systems and applications to service quickly, through a set of efficient design and combining coarse-grained services. Operational staff will be able to effectively mix of new business processes and applications (National Information Technology Standardization Technical Committee SOA Standards Working Group, China Electronics Standardization Instituted 2012).

The design of application includes modular design, lifecycle Management (Cao 2006), and business portfolio. It can ensure the system's openness and ease of expandability, optimization of new business, shorten product cycles, eliminate risks associated caused by the system changes, improve the speed of service response and fully utilize system resources.

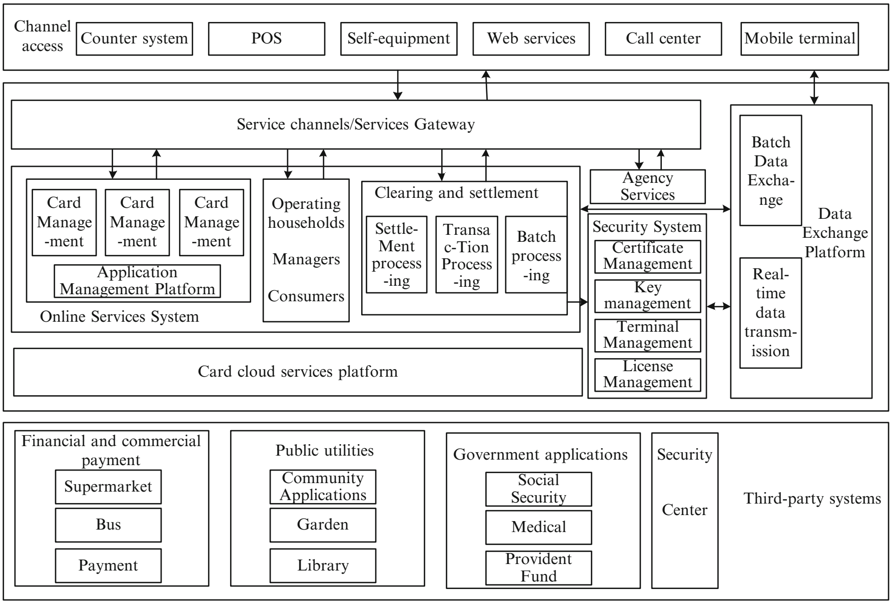

Fig. 1 Logical structure of smart payment card of markets' cloud platform

3.3 Overall Technical Program

The platform system structure consists of Smart payment card cloud services platform infrastructure as a service, platform as a service, software as a service, customer base and support system. Wherein, support system including security systems, operation system and standard system. Infrastructure as a service layer using the localization hardware and software, achieve virtualization of host resources, storage resources, network resources as well as the unified management of the three. Platform as a service layer mainly virtualize these services for the consumption of SaaS, and bring the traditional middleware, database, messaging middleware, and other service resources to resource pool. Software as a Service Layer in the smart payment card of cloud infrastructure management, application service management, service channel Management, put the smart payment card services into virtualization management, in order to achieve differentiation, customization of the service.

Logical relationship between the various parts of the smart payment card of markets' cloud platform in Binhai New District is shown in Fig. 1.

1. *Smart payment card cloud services platform*: in order to provide a rapid service delivery platform, including two systems: card cloud of Channel Integration System, it can make user terminal unified access channels and centralized control

of user access; Card cloud services gateway system, it can be Integrated with third party systems.

2. *Smart payment card applications and software systems mainly consists of four parts*: Core Systems, Including claims and delivering of cards, the services for citizens and the scheduling of card produce background like Card Application Management, Card File Management, blacklist Management and so on. Sites are channels of smart payment card services and online advertising. Whereby the cardholder or the public may obtain service advice, participate in interactive exchanges and so on. Self-service terminals directly provide cardholders with balance inquiries of citizen card, detail record query of transaction, service guide inquiry, change of password and so on. Customer service center provide the public with the introduction of smart payment cards, information inquiry, card services, membership management, special services, technical services, feedback and other voice telephone services.
3. *Cloud Service Management Platform*: according to customer demand, for services, software, hardware management.
4. *Cloud service monitoring platform (CBVM)*: Including service monitoring subsystem, event Management subsystem and system and data monitoring subsystem. They together constitute the platform for centralized monitoring and management framework. Through the system and application level report file, alarm and other data collection summary and Statistical analysis of monitoring traffic, service access, performance status and so on. Then Real-time compare with the capacity threshold to publish reports, alarms and other forms of unified reporting threshold overrun situation, Thus we can meet the requirements of smart payment card cloud service platform' operation and maintenance.

4 Conclusion

The cloud-based managerial modes of traceable markets provide government public services, at the same time it can achieve sustainability and efficient operation of input and output, as well as social and economic benefits of a win-win.

In economic aspects, Smart payment card of markets' cloud services platform unified based and distributed data, sharing information resource layer, making full use of IT resources, avoiding duplication and bring direct economic benefits. It can be applied in the financial services, community management and so on. Platform can improve management efficiency, labor productivity of related business operators, suppliers, and produce indirect economic benefits.

In social aspects, the win-win model and brand effect of managerial modes of traceable markets enhance the ability of the government's public service, meanwhile innovative new mode of the urban population management and public services. The model establish the basis of improving government urban management refinement, intelligence and enhancing the ability to govern, and produce significant social benefits.

The cloud-based managerial modes of traceable markets, through the support of systems integration and cloud computing technologies, intelligent decision support project, Quality traceability, the share of information and resource of price monitoring system. The mode significantly enhanced the vegetable market management department rapid response capability bringing significant economic benefits In the short-term and long-term for market and business committee.

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Breakthrough Problem Solving Using TRIZ Component Trimming

D. Daniel Sheu and Chun Ting Hou

Abstract Based on TRIZ (Theory of Inventive Problem Solving) methodology, the systematic component Trimming Algorithm to solve Process-Equipment Problems is used to trim components of any physical devices/products without compromising its performance and to resolve process-machine problems by re-designing the problematic processing machines with fewer components and less cost. Applied on a slit-valve failure of a piece of chemical vapor deposition equipment in one of major Taiwanese foundry companies, the proposed problem solving process successfully identified the critical key disadvantages of the problem and solved the slit-valve failure. The paper contributes to establish an integrated trimming process consistent with TRIZ problem-solving mode and capable of breakthrough problem solving and cost savings, effectively solving the slit-valve problem. The results have been converted into a patent pending approval.

Keywords Systematic innovation • Trimming • TRIZ

1 Introduction

When facing engineering problems, the great majority of engineers tend to use "Addition" or "Substitution" methods to solve problems. For example, when an electronic component generates radio interference with other components, engineers almost always introduce a cap to block out the interference. When a river floods, civil engineers will build a dam to protect the lands from being flooded. This method of introducing additional elements to solve a problem constitutes the mind set of "Addition" to solve a problem. Some people may use "Substitution" to

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solve a problem by replacing the problematic component. It is estimated that some 99 % of people tend to use “Addition” or “Substitution” methods to solve problem. This paper established theoretical foundation and a systematic way of using “Subtraction” to solve problems consistent with TRIZ (Theory of Inventive Problem Solving) problem solving model (Altshuller 1998, 1999).

2 Methodology

This section demonstrates the application of the proposed trimming process on semiconductor equipment with significant improvements. Other examples are available but omitted due to confidentiality concern and space limitation of the paper (Sheu 2011).

The partial pictorial view of one of the chambers in connection with the transfer module and the slit valve, also known as gate valve, is shown in Fig. 1. The full mechanism of the slit valve is shown in Fig. 2 where 18 components, some parts and some assemblies, are indicated. The problem came when consistent defect patterns were found on the processed wafers. Engineers traced back to locate the causes and determined that the unexpected breakage on one of the two protruding pins, red circled in Fig. 2, of the Sliding Guide Assembly (part #5) caused the cover plate to close the door unevenly. The uneven movements of the cover to release particles. The particles were sucked in by the vacuum operation in the process chamber and deposited on the wafer at the area close to the gate opening. Figure 3 shows the sliding guide assembly with protruding pins indicating where the mechanical fatigue and stress concentration occurred.

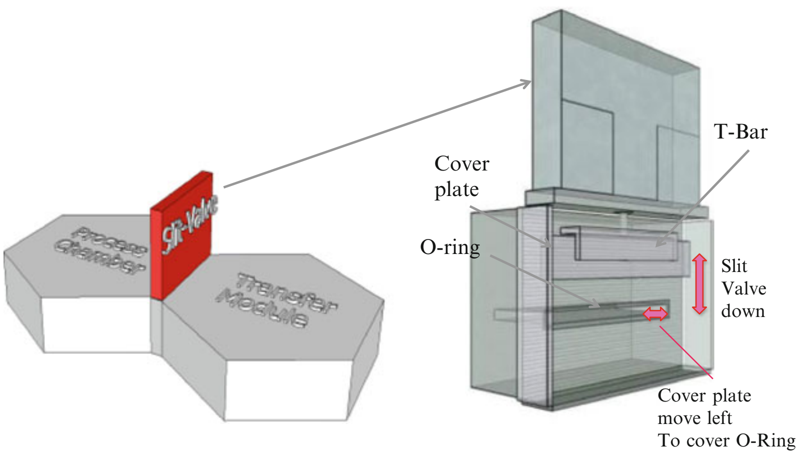

Fig. 1 Pictorial view of the slit valve and the chamber

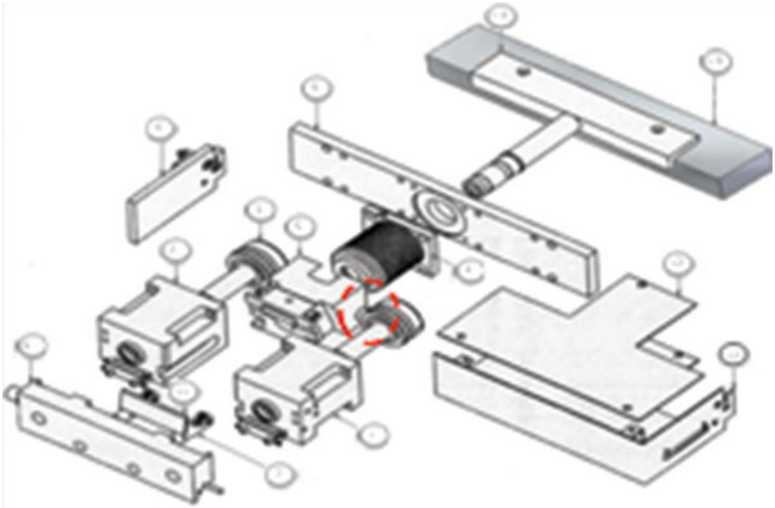

Fig. 2 Construction of the slit calve mechanism

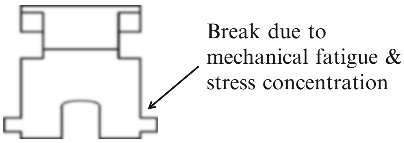

Fig. 3 Root sore point at the pin of the sliding guide assembly

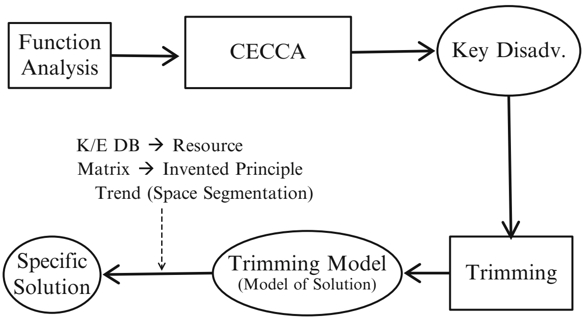

Fig. 4 The trimming process

The authors applied the "Problem Solving by Trimming" approach. The overall steps to solve this problem are show in Fig. 4.

Slit-value functional model of the system is given in Fig. 5.

CECCA of the problem is given in Fig. 6.

The CECA starts from the surface sore point of the system as the target disadvantage(s) to be fixed. It then reasons for the causes of the target disadvantage

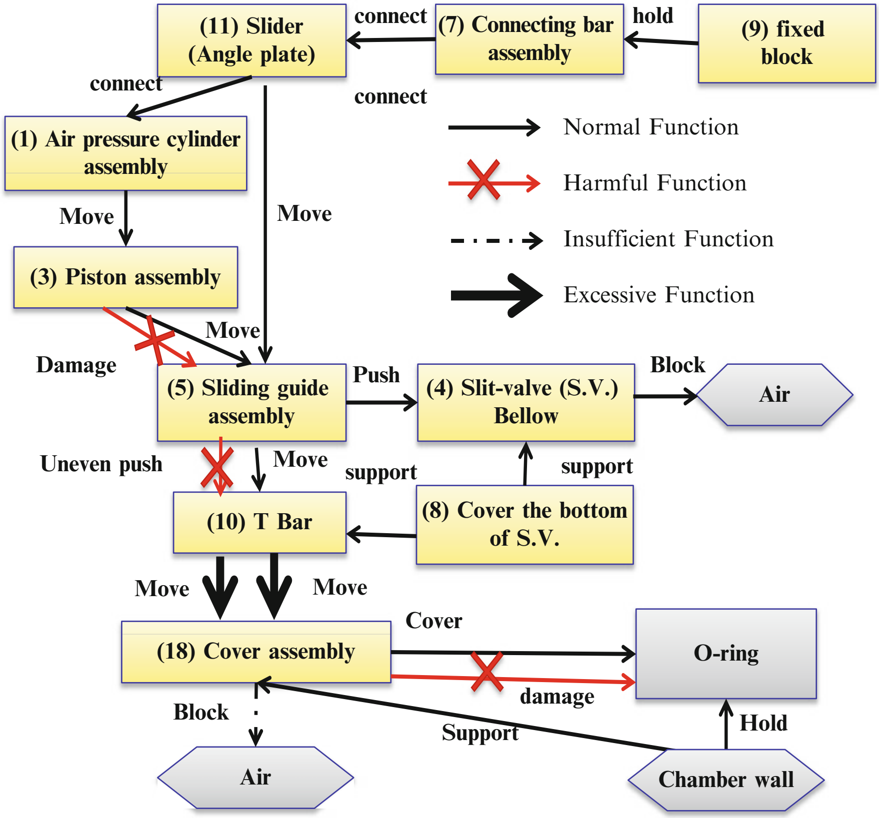

Fig. 5 Functional model of the system under failure situation

in hierarchy till the lowest level key disadvantages on the far right in the figure. The fundamental causes at the lowest layer are the Key Disadvantages. The goals of CECCA are:

- Providing a hierarchical relationship of the problem cause structure so that one can attack the problem from the lowest fundamental level on the far right of Fig. 5. If we are not able to solve the problem at the most fundamental level, we can step back one level at a time to solve the problem at the less fundamental level. While starting from the key disadvantages backward, as long as we can solve the problem causes at any level the original target disadvantage will be resolved. CECCA provide us a full spectrum of problems to attack in order to solve the target disadvantage. Therefore, multiple solutions are quite possible due to the exposure of problem spectrum by CECCA.
- Allowing us to identify the contradictions underneath the surface disadvantage(s). By assigning the corresponding parameters associated with the subject cause items, the authors are able to identify the underlying contradictions of the

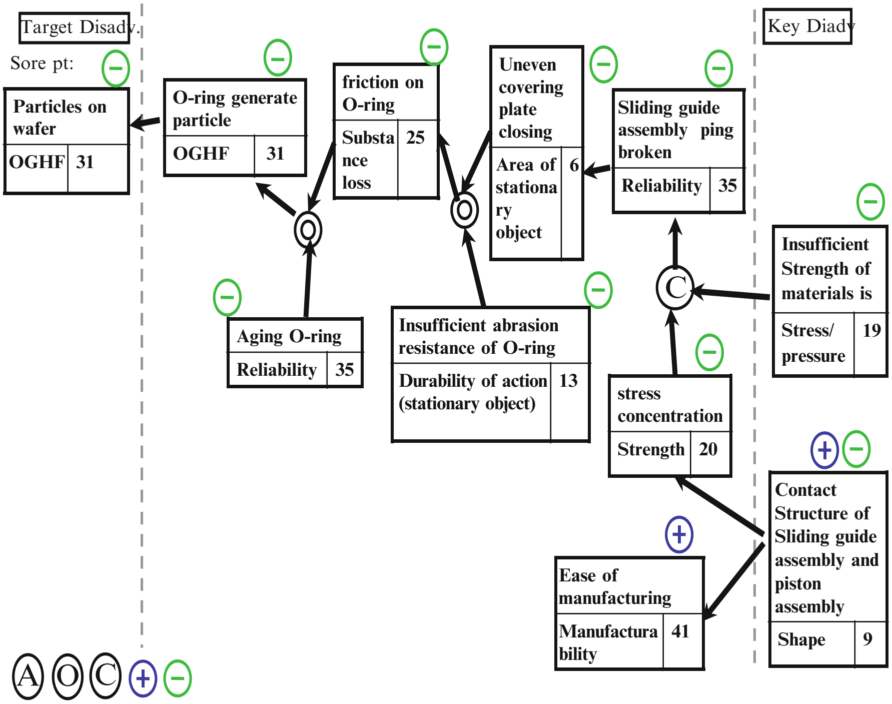

Fig. 6 Cause effect contradiction chain analysis

surface disadvantage thus enabling us to use Contradiction Matrix and Inventive Principles to solve the problem. After constructing the CECA, all the causes posted on the diagram are the disadvantages or some sort of failure. Therefore, they are all marked as (−) in a circle. We then examine for each disadvantage item, if there is anything good that this "bad" thing can produce? If there is, we have contradiction(s). The subject disadvantage not only contributed to the disadvantages above its cause-effect hierarchy (to the left on Fig. 5), it also contributed to the identified good thing. Therefore, the parameter associated with this subject disadvantage is under "physical contradiction" where contradictory requests are being asked on the parameter of the same system. The spot of physical contradiction is indicated by a (+) and a (−) circles side-by-side. Then, the "good" thing, marked as (+) circle, and the downstream bad things caused by the subject disadvantage may form "Engineering Contradictions" where contradiction requests are asked of two parameters.

Based on the CECCA, the insufficient strength of materials, the fatigue, and the contact structure of **sliding guide assembly** and **Piston assembly** are the key disadvantages. Addressing the material strength problem may be costly. The authors decided to address the problem from the contact structure of the sliding guide assembly and piston assembly. This determines the priority point to address. It is

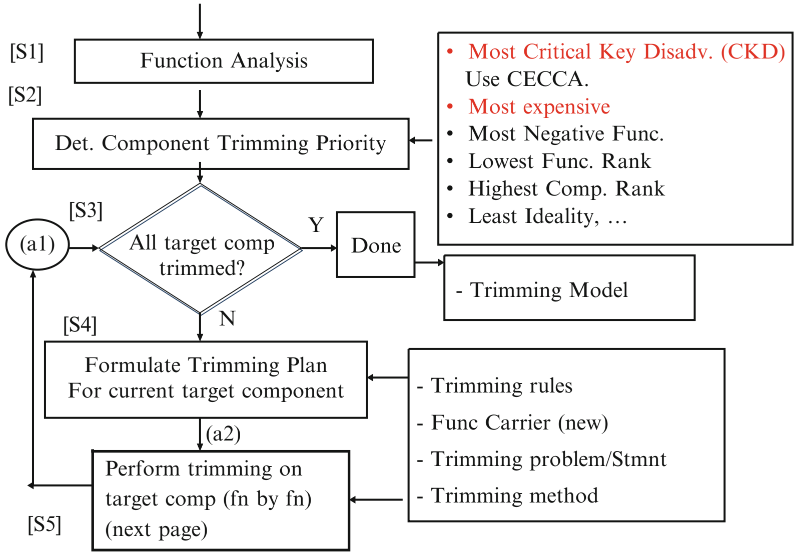

Fig. 7 Outer loop of the trimming process

the contact between the piston assembly and the sliding guide assembly where the pin of the sliding guide assembly is broken.

The mind set of using Trimming to solve a problem is to ask:

1. What is the critical key disadvantage of the problem from CECCA. Answer: The piston assembly broke the pin of the sliding guide assembly.
2. Which component is the problem maker? Can we trim it?

Figure 7 shows the outer loop of the proposed trimming process.

- Step [S1]: Functional analysis (FA) of the current system is executed and the current FA model is the starting point for the trimming process.
- Step [S2]: This step determines the component(s) to be trimmed and their priority of trimming. Many ways have been proposed for determination of component trimming priority. The authors specifically recommend either the "Most Critical Key Disadvantage" or the "Most expensive components" be used for determination of trimming priorities.
  - Most Critical Key Disadvantages: Disadvantages refer to the negative functions found in the FA model. They include harmful functions, excessive functions, and insufficient functions. Usually, the harmful functions are the priority target(s) of elimination. Cause Effect Chain Analysis (CECA) or Cause Effect Contradiction Chain Analysis (CECCA) can be used to identify Key disadvantages and the most critical key disadvantages (Sheu and Tsai 2012; Sheu et al. 2012). CECA starts from a target disadvantage, where the sensed sort point is, step-by-step sorting out the causes of the underlying

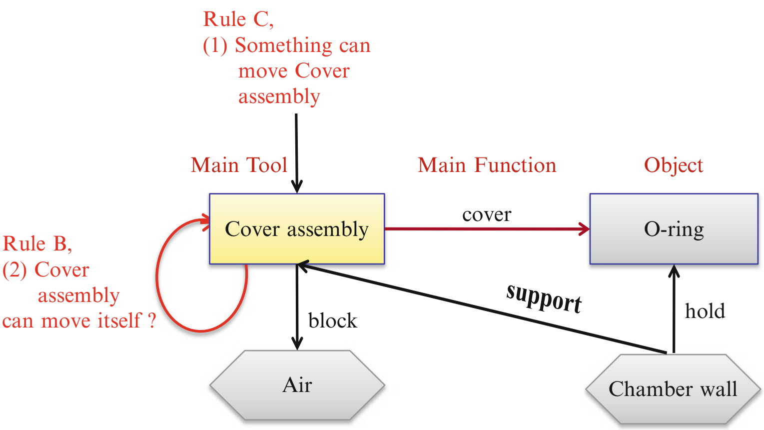

Fig. 8 Final trimming model

negative events that caused the surface sore point. The negative events at the very bottom of the cause hierarchy are the Key Disadvantages. The Critical Key Disadvantages are the minimum set of Key Disadvantages which if eliminated will eliminate all the target disadvantages of concern. The CECCA is an enhancement of CECA with the addition of the relevant parameters for the negative event and the positive event generated from the negative events enabling the identification of contradictions.

– Another recommended way to prioritize the components to be trimmed is based on the cost of each component. Naturally, the higher the component costs, the higher the priority to be trimmed.

Step [S3], [S4], and [S5]: These constitute the outer and inner loops of the trimming where each component to be trimmed are examined for trimming one by one.

This research uses trimming method and deletes a lot of components. At the end, the final trimming model is given in Fig. 8.

TRIZ Function Database is available for us to examine all principles that have been used in past patents on how to move solids. At least 36 ways of move solid can be found from CREAX Function Database [CREAX]. Further examining resources around the system, the authors determined that the three principles, Ferro-magnetism, Gravity, and Pressure Differential be used to substantiate the trimming model. Among them, gravity and pressure differential are free existing resources in the environments.

Furthermore, using the identified possible contradictions from the CECCA previously, the authors used Darrell Mann's Matrix + software to locate the probably principles that can provide solution ideas. The identified possible parameter to improve are (19) Stress, (20) Strength, (25) Loss of substance, (35) Reliability; The identified stopping factors are (45) System Complexity and (41) Manufacturability.

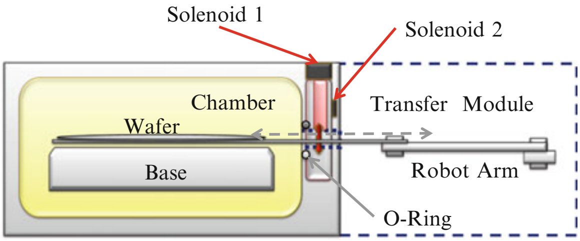

Fig. 9 Representative solution of the slit valve

A number of principles were suggested by the Matrix+. The ones which we were able to draw specific solutions are (17) Another Dimension, (3) Local Quality, (28) Mechanics Substitution, and (13) The Other Way around. The one used in this solution for trimming is the principle 13, "The Other Way Around", generated the idea of embedding the cover plate inside the chamber wall instead of the traditional mechanism attaching onto the chamber wall. Side view of a representative solution is given in Fig. 9.

The key points of the solution are:

- Instead of original huge external mechanical structure of 18 components/assemblies, the trimmed solution uses only 3 components: one cover plate inside the chamber and two solenoid valves on the side and on the top of the cover plate. The cover plate consists of magnetically attractable materials so that the solenoid valves can move the cover plate.
- During the closing operation, the gravity force moves down the cover plate without using any energy costs. The tightening of the valve can be achieved automatically by the pressure differential between the chamber and the transfer module. The chamber vacuum is needed by the process chamber before the wafer manufacturing processes. No additional operational energy is needed during the closing and the state of slit valve being closed. This constitutes 90 % of the time for the equipment operations. To loosen the cover plate and open the slit valve, the side solenoid valve applies a pulse of energy to pull the cover plate away from the O-Ring and the top solenoid applies a pulse of energy to suck the plate up and open the gate. Unlike in the original mechanical operations, energy is needed all the time to move the approximately 6 kg cover mechanism and to maintain it, the proposed trimmed solution, needs only 10 % of time to apply energy on solenoid valves and taking the load of approximately 0.6 kg cover plate. With 10 % of time needing energy to operate and approximately 10 % of original loading when needing the energy, the trimmed solution takes approximately 1 % of original energy to operate.
- In addition, using TRIZ Trend of Space Segmentation, we can make the cover plate hollow or multiple hollow to further reducing its weight.

3 Results

Compared to the original solution by the original equipment builder or the company's engineers, the benefits of the trimming solution are summarized in Table 1. The advantages of this trimming solution include:

- Eliminating the original equipment failure mode of pin breakage permanently by system redesign. The new system uses well-known reliable components with much fewer numbers of components and is less prone to failure.
- Significantly reducing the part count from 18 to 3 – a reduction of more than 80 % part count and 95 + % of component costs.
- Taking advantage of existing resources, gravity and pressure differential, to close and tighten the valve for 90 % of the time. Together with the reduction of 90 % weight loading, the savings in operational energy is theoretically 99 %.
- Embedding the slit-valve in the Chamber wall greatly reducing the overall space and materials usage.
- Allowing voids inside the cover plate to further reducing the weight thus energy and materials usage.

4 Conclusions

This research established a theoretical framework and a systematic way of trimming products with physical components. It is termed as "Device Trimming" as contrasted to "Process Trimming" and "Organizational Trimming". The model of device trimming process is formulated in a way consistent with TRIZ problem solving model. Trimming Plan was introduced to orchestrate all the Trimming Tasks which in turn apply Trimming Rules, Trimming Statements, to "virtually" trim the system into a Trimming Model. The Trimming Model is used to direct our thoughts of

Table 1 Comparing the original and the trimmed solutions

	Item	Before	After	Improvement (%)
Original solution	Component Counts	18	20	(18–20)/18 = −11.1 %
	System cost	NTD 229,000	NTD 80,000	NA
	Energy savings	None	None	Need energy to maintain 6 kg*20 (min)
Trimmed solution	Component Counts	18	3	(18–3)/18 = 83.3 %
	System cost	NTD 229,000	<NTD 10,000	(229,000–10,000)/229,000 = 95.6 %
	Energy savings	120	1.2	From 6 (kg)* 20 (min) full cycle to 0.6 (kg)* 2 (min) only in "open" state.

physical trimming into Specific Solution(s). A two-loop recursive trimming process was introduced to maximize the extent of trimming. The proposed method was tested on a semiconductor equipment problem with significant improvements which include more than 80 % component count reduction, 95 % of rebuild cost reduction, and approximately 99 % of operational energy savings.

Contributions of the paper includes: (1) Establishing the process and theory of trimming connecting it with TRIZ problem solving process; (2) Creating a Trimming plan to systematically organize the trimming steps in the trimming process; (3) Creating a 2-loop Recursive Trimming algorithm to maximize the trimming power; (4) Demonstrating a way to utilize Resources for trimming; (5) Applying the method to solve a semiconductor process-equipment problem with significant improvements.

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A Method Based on Grey Theory for Multiple Attribute Group Decision-Making Considering Decision Makers' Risk Attitudes

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Abstract A new method is developed for solving multiple attribute group decision-making (MAGDM) problems considering decision makers' risk attitudes, where attribute values are represented in interval grey numbers with incomplete weight information. In the proposed method, the risk attitude factors of decision makers are introduced, and interval values are transformed into exact values. Then, the weight vector of the decision makers for attributes is obtained by using the gray autocorrelation matrix. Further, the grey correlation matrix is employed to rank the alternatives. Finally, an example is used to illustrate the applicability of the proposed method.

Keywords Grey theory • Incomplete weight information • Multiple attribute group decision making (MAGDM) • Risk attitude

1 Introduction

Multiple attribute decision making (MADM) has been extensively applied to various areas, such as society, economics, management, military and engineering technology (Peide Liu et al. 2011). Because engineering or management decision information is often vague, imprecise and uncertain, a general tendency in the literature is to investigate group decision models with incomplete information (Zhi Xiao et al. 2013). The fuzzy set theory has got a wide range of application in group decision making (Meimei Xia et al. 2013), as an alternative approach, recent years a number of authors have provided interesting results on decision making with the help of grey theory (Meng Ke et al. 2007). However, the existing studies on

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grey theory to solve multiple criteria decision problems either failed to take into consideration decision makers' risk attitudes under the situation of multiple attribute group decision making (MAGDM) (Meng Ke et al. 2007), or not considering imprecise or incomplete weights (Luo Dang et al. 2008), or just not taking into account the decision makers' risk attitudes (Chen Xiao-xin and Liu Si-feng 2009; Liu Pei-de and Zhang Xin 2011; Wang He-hua et al. 2012, 2013; Liu Lang et al. 2013; Peide Liu 2013; Zavadskas et al. 2009).

Different decision makers often have different risk attitudes, or risk preferences (Meng Ke et al. 2007), and MAGDM with partial weight information is known or the attribute values of alternatives are interval grey numbers in management, economics, behavior science and engineering (Chen Xiao-xin and Liu Si-feng 2009). Therefore, both grey theory and decision makers' risk attitudes are introduced into MAGDM in this article. We will employ the risk attitude factor of decision maker to transform an interval grey value into an exact value. In order to reflect the consistency of MAGDM, the weight vector of the decision-makers for attributes is determined by applying the grey autocorrelation matrix. Finally, the grey correlation matrix is introduced to rank the alternatives.

The rest of this paper is arranged as follows. In Sect. 2, some basic concepts and definitions on grey numbers, self-GR matrix and risk attitude factor are introduced. Section 3 develops a novel approach to solve MAGDM problems, taking into consideration the decision makers' attitudes toward risk under uncertain environment, in which attribute values are interval grey numbers with incomplete weight information. Section 4 gives an illustrative example. Finally, Sect. 5 presents our concluding remarks and discussions.

2 Preliminaries

2.1 Grey Numbers

A grey number is a number whose exact value is unknown, but a range within which the value lies is known. There are the several types of grey numbers (Zavadskas et al. 2009).

- Grey numbers with only lower limits: $\otimes \in [\underline{x}, \infty)$ or $\otimes(\underline{x})$, where a fixed real value $\underline{x}$ represents the lower limit of grey number $\otimes$.
- Grey numbers with only upper limits: $\otimes \in (-\infty, \overline{x}]$ or $\otimes(\overline{x})$, where x is a fixed real number or an upper limit of grey number $\otimes$.
- Interval grey number is the number with both lower limit $\underline{x}$ and upper limit $\overline{x}$: $\otimes \in [\underline{x}, \overline{x}]$.
- Continuous grey numbers and discrete grey numbers. The grey numbers taking a finite number of values or a countable number of values in an interval are called discrete. The continuously taking values, which cover an interval, are continuous.

- Black and white numbers. When $\otimes \in (-\infty, \infty)$ or $\otimes \in (\otimes_1, \otimes_2)$, i.e., when $\otimes$ has neither upper nor lower limits, or the upper and the lower limits are all grey numbers, $\otimes$ is called a black number. When $\otimes \in [\underline{x}, \overline{x}]$ and $\underline{x} = \overline{x}$, $\otimes$ is called a white number.

In this article, attribute values of alternatives and the weights of attributes provided are interval grey numbers.

The grey relational analysis is said to be gray correlation matrix when the reference series is given, otherwise it will be called as self-GR matrix with the condition that every series can be taken by arbitrary decision as reference. Detail information can be found in reference (Yi Lin et al. 2004; Deng 2005).

2.2 Risk Attitude Factor

By introducing the risk attitude factor of decision makers, we can transform an interval value into an exact value. The exact values $a_{ij}(k)$ are given as follows (You and Fan 2002).

$$a_{ij}(k) = \overline{\overline{a_{ij}(k)}}, +\varepsilon_k \underline{\underline{a_{ij}(k)}}, i = 1,2,\ldots,n; j = 1,2,\ldots,m; k = 1,2,\ldots,l \quad (1)$$

where $\overline{\overline{a_{ij}(k)}}$ represents the middle value of interval value $\widehat{a_{ij}(k)} = \left[\overline{a_{ij}(k)}, \underline{a_{ij}(k)}\right]$, and $\overline{\overline{a_{ij}(k)}}$ calculated by $\overline{\overline{a_{ij}(k)}} = \frac{\overline{a_{ij}(k)}+\underline{a_{ij}(k)}}{2}$, $\underline{\underline{a_{ij}(k)}}$ represents the width of interval value $\widehat{a_{ij}(k)} = \left[\overline{a_{ij}(k)}, \underline{a_{ij}(k)}\right]$,and $\underline{\underline{a_{ij}(k)}} = \underline{a_{ij}(k)} - \overline{a_{ij}(k)}$. The risk factor ε_k represents the risk attitude of the kth decision maker. If the decision maker g_k is risk averse, then the range of risk factor will be $-0.5 \leq \varepsilon_k < 0$. If then decision maker g_k is risk neutral, the risk factor $\varepsilon_k = 0$. While the decision maker k is risk preferred, then the range of risk factor will be $0 \leq \varepsilon_k < 0.5$. The smaller ε_k is, the greater risk averse of the decision maker will be. In the specific decision problem, ε_k can be determined by experts or organizers of group decision making based on individual risk preference.

3 Methodology

3.1 The Description of the Decision Making Problems

Let $D = \{d_1, d_2, d_3, \ldots, d_n\}$ be a discrete set of alternatives, consisting of n non-inferior alternatives, and $A = \{a_1, a_2, a_3, \ldots, a_m\}$ be the set of attributes. Each alternative is assessed on the m attributes. Let $G = \{g_1, g_2, g_3, \ldots, g_l\}$ be the set of decision makers. Let R denote the decision matrix, $v_{ij} = \left\{\underline{v_{ij}}, \overline{v_{ij}}\right\}$ is an attribute value, i.e., the consequence for candidate d_i ($i = 1, 2, \ldots, n$) with respect to attribute a_j ($j = 1, 2, \ldots, m$). Because in reality it is difficult for decision makers to provide clear or exact weights concerning attributes, and different decision maker often provide different weight for one attribute, interval grey numbers are used to express the weights of attributes provided decision makers. Let W denote the weight matrix, $w_j{}^k = \left\{\underline{w_j{}^k}, \overline{w_j{}^k}\right\}$ $\left(0 \le \underline{w_j{}^k} \le 1, 0 \le \overline{w_j{}^k} \le 1\right)$ is the weight of attribute a_j provided by decision maker g_k. The decision problem is to select a most preferred alternative from set D based on the decision matrix R and the weight matrix W.

3.2 The Proposed Method

We develop a new and practical method considering the decision makers' risk attitudes for solving multiple attribute group decision-making problems based on grey theory. The method involves the following steps:

Step 1 Transform the inter-valued grey number into an exact value by using Eq. (1). Then, R and W can be transformed into $\underline{\tilde{R}}$ and $\underline{\tilde{W}}$.

$$\underline{\tilde{R}} = \begin{bmatrix} \tilde{v_{11}} & \tilde{v_{12}} & \tilde{v_{13}} & \cdots & \tilde{v_{1m}} \\ \tilde{v_{21}} & \tilde{v_{22}} & \tilde{v_{23}} & \cdots & \tilde{v_{2m}} \\ \tilde{v_{31}} & \tilde{v_{32}} & \tilde{v_{33}} & \cdots & \tilde{v_{3m}} \\ \vdots & \vdots & \vdots & & \vdots \\ \tilde{v_{n1}} & \tilde{v_{n2}} & \tilde{v_{n3}} & \cdots & \tilde{v_{nm}} \end{bmatrix},$$

$$\underline{\tilde{W}} = \begin{bmatrix} \tilde{w_1}^1 & \tilde{w_2}^1 & \tilde{w_3}^1 & \cdots & \tilde{w_m}^1 \\ \tilde{w_1}^2 & \tilde{w_2}^2 & \tilde{w_3}^2 & \cdots & \tilde{w_m}^2 \\ \tilde{w_1}^3 & \tilde{w_2}^3 & \tilde{w_3}^3 & \cdots & \tilde{w_m}^3 \\ \vdots & \vdots & \vdots & & \vdots \\ \tilde{w_1}^l & \tilde{w_2}^l & \tilde{w_3}^l & \cdots & \tilde{w_m}^l \end{bmatrix}$$

Step 2 Calculate the weighted normalized decision matrix Y^k ($k = 1, 2, 3 \ldots, 1$).

$$Y^k = \begin{bmatrix} y_{11}{}^k & y_{12}{}^k & y_{13}{}^k & \cdots & y_{1m}{}^k \\ y_{21}{}^k & y_{22}{}^k & y_{23}{}^k & \cdots & y_{2m}{}^k \\ y_{31}{}^k & y_{32}{}^k & y_{33}{}^k & \cdots & y_{3m}{}^k \\ \vdots & \vdots & \vdots & & \vdots \\ y_{n1}{}^k & y_{n2}{}^k & y_{n3}{}^k & \cdots & y_{nm}{}^k \end{bmatrix}$$

where $y_{ij}{}^k = \tilde{v_{ij}} \times \tilde{w_j}{}^k$.

Step 3 Obtain the weight vector of the decision-makers by using the grey autocorrelation matrix.

According to self-GR, it is easy to calculate the similarity between the kth decision maker and tth decision maker, and let r_{kt} denotes this relationships. Therefore, the similar matrix S consists of r_{kt}. Let b_k denotes sum of the row vector for S, which reflects the deviation of the weights between kth decision maker and decision maker group (including himself). The smaller b_k is, then the higher the deviation degree between ith decision maker and group is.

$$b_k = \sum_{t=1}^{l} r_{kt} \tag{2}$$

In order to reflect the consistency of MAGDM, let B denote the sum of b_k.

$$B = \sum_{k=1}^{l} b_k \tag{3}$$

The weight of the kth decision maker can be easily obtained by

$$w_k = \frac{b_k}{B} \tag{4}$$

The weight vector of the decision-makers can be denoted as $W = \left(\frac{b_1}{B}, \frac{b_2}{B}, \frac{b_3}{B}, \ldots., \frac{b_l}{B}\right)$.

Step 4 Calculate the final decision matrix F with the help of the weighted normalized decision matrix Y^k and the weight vector of the decision-makers W.

$$F = \sum_{k=1}^{l} w_k Y^k \tag{5}$$

Step 5 Calculate the grey correlation coefficient CR_i $(i = 1, 2, 3, \ldots, n)$ based on the final decision matrix F by using the gray correlation matrix.

Step 6 Rank all the alternatives according to the size of the CR_i for each one.

4 Illustrative Example

In order to demonstrate how our approach can be applied to group decision-making problem, we use the numerical examples that have been used in references (Zhi Xiao et al. 2013).

We consider an evaluation question of colleges at the university. It usually use teaching, scientific research and service as evaluation index. Let us suppose there are five colleges waiting to be evaluated, and a decision group consists of five decision makers. Both the attribute values of each college are given by experts and each attribute's weight of college are given by decision makers in the form of interval grey numbers. The original data are given in reference (Zhi Xiao et al. 2013).

In order to understand the influence of decision maker's risk attitude on decision making, we propose the following scenarios for discussion.

Scenario one The five decision makers are risk preferred. Let $\varepsilon_k = 0.4(k = 1, 2, 3, 4, 5)$, and using the method proposed in this paper, it is easy to get $\mathrm{CR}_i(i = 1,2,3,4,5)$ values.

$\mathrm{CR}_1 = 0.56$, $\mathrm{CR}_2 = 0.69$, $\mathrm{CR}_3 = 0.67$, $\mathrm{CR}_4 = 0.41$, $\mathrm{CR}_5 = 0.44$.

From the CR_i values, it is easy to rank the alternatives: D2 $\succ$ D3 $\succ$ D1 $\succ$ D5 $\succ$ D4, and thus, the most desirable alternative is A2, which is consistent with the literature (Zhi Xiao et al. 2013) conclusions.

Scenario two The five decision makers are risk neutral. Let $\varepsilon_k = 0(k = 1, 2, 3, 4, 5)$, and then the $\mathrm{CR}_i(i = 1,2,3,4,5)$ values are:$\mathrm{CR}_1 = 0.56$, $\mathrm{CR}_2 = 0.75$, $\mathrm{CR}_3 = 0.66$, $\mathrm{CR}_4 = 0.41$, $\mathrm{CR}_5 = 0.44$.

From the CR_i values, we can get the same rank like scenario one.

Scenario three The five decision makers are risk averse. Let $\varepsilon_k = -0.35(k = 1, 2, 3, 4, 5)$, and then the $\mathrm{CR}_i(i = 1,2,3,4,5)$ values are: $\mathrm{CR}_1 = 0.51$, $\mathrm{CR}_2 = 0.78$, $\mathrm{CR}_3 = 0.65$, $\mathrm{CR}_4 = 0.42$, $\mathrm{CR}_5 = 0.44$.

From the CR_i values, we can get the same rank like scenario one.

Scenario four The five decision makers have different risk attitude. Let $\varepsilon_1 = -0.5$, $\varepsilon_2 = -0.2$, $\varepsilon_3 = 0$, $\varepsilon_4 = 0.35$, $\varepsilon_5 = 0.4$, and then the $\mathrm{CR}_i(i = 1,2,3,4,5)$ values are: $\mathrm{CR}_1 = 0.56$, $\mathrm{CR}_2 = 0.77$, $\mathrm{CR}_3 = 0.65$, $\mathrm{CR}_4 = 0.38$, $\mathrm{CR}_5 = 0.40$.

From the CR_i values, we can get the same rank like scenario one.

Scenario five The five decision makers have different risk attitude. Let $\varepsilon_1 = -0.2$, $\varepsilon_2 = 0.3$, $\varepsilon_3 = 0.1$, $\varepsilon_4 = 0.4$,

$\varepsilon_5 = 0.2$, and using the method proposed in this paper, it is easy to get $\mathrm{CR}_i(i = 1,2,3,4,5)$ values.

$\mathrm{CR}_1 = 0.56$, $\mathrm{CR}_2 = 0.68$, $\mathrm{CR}_3 = 0.66$, $\mathrm{CR}_4 = 0.39$, $\mathrm{CR}_5 = 0.44$.

From the CR_i values, we can get the same rank like scenario one also.

5 Conclusion and Discussion

This article puts forward a framework to tackle multiple attribute group decision-making problems considering decision-makers risk attitude by using grey theory. Numerical example illustrates the feasibility of this proposed framework: it is capable for handling the situation where attribute values are interval grey numbers with incomplete weight information.

The numerical example also implies that it is necessary to consider decision-makers risk attitude for multiple attribute group decision-making problems (see scenario one to scenario five as examples; particularly the CR_2 of scenario one and scenario three where the value of the first is 12.54 % lower than the latter one.). In future research, our work will focus on exploring why there are differences in ranking alternatives between the method proposed in this paper and that in literature (Zhi Xiao et al. 2013).

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Chaotic Simulated Annealing Quantum-Behaved Particle Swarm Optimization Research

Ai-jun Liu, Hua Li, and Ming Dong

Abstract In order to solve the premature convergence problem of Quantum-behaved Particle Swarm Optimization (QPSO), a Chaotic Simulated Annealing Quantum-behaved Particle Swarm Optimization (SAQPSO) is presented. Particles in population are first initialized using Logistics chaotic mapping, which in return, improve the global convergence performance of algorithm. Simulated annealing algorithm is introduced, with a certain probability of accepting bad solutions, enriches the population diversity, and improves the ability of global optimization. Adaptive temperature decay coefficient is introduced, so the simulated annealing algorithm can automatically adjust the search based on the current environment conditions, so as to improve the search efficiency of the algorithm. Results on Benchmark functions show that the proposed algorithm shows better search and convergence performance than standard QPSO and other algorithms.

Keywords Chaos optimization • Quantum-behaved Particle Swarm Optimization (QPSO) • Simulated annealing algorithm

1 Introduction

Production scheduling is an important part of production management and control. Production scheduling optimization is helpful to improve the utilization of enterprise resources, enhance the competitiveness of enterprises. Therefore, research on

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application and optimization of production scheduling problem has the important theory significance and the practice significance. In recent years, many scholars use genetic algorithm, simulated annealing algorithm and particle swarm optimization algorithm (Particle Swarm Optimization, PSO) and other intelligent optimization algorithm to solve job-shop scheduling problem, satisfactory results have been achieved.

The basic idea of PSO is through cooperation and information sharing between the individual groups to find the optimal solution. At present, this algorithm has been widely applied. During the search, convergence of particles is achieved by track form, and the particles with maximum speed limit, therefore, the search area is limited, PSO algorithm cannot converge to the global optimal value at probability 1. In recent years, many scholars study the algorithm structure and the performance of the algorithm, including the analysis of parameters, topology structure, the diversity of particles, algorithm fusion. Among them, the quantum particle swarm algorithm (Quantum Particle Swarm Optimization, QPSO) is favored by researchers. QPSO derives from the theory of quantum mechanics and PSO model. It can guarantee the global convergence, but also it has only position vector in the optimization model, not the velocity vector. The algorithm has a powerful search capability because there are less control parameters. But, like other evolutionary algorithms, it also has the defect of premature convergence, and a reduction in the diversity of the particles of the late convergence. To solve this problem, scholars propose some improved algorithms: QPSO algorithm is put forward based on Gaussian probability distribution by Coelho (2007), the mutation operator was introduced in the algorithm; based on the QPSO algorithm, the literature (Long et al. 2010) introduced the selection operation Championships and roulette wheel to improve the global convergence ability of QPSO algorithm; Sun et al. (2006) Proposed DGQPSO (Diversity-Guided Quantum-behaved Particle Swarm Optimization) based on population diversity, the algorithm implements mutation operation according to population diversity, in order to prevent the population gathered, strengthen the particles to escape from local minima. The above algorithms make the particle jump out of local minimum mostly through the variation method, and broader solution search space. But for the population diversity maintaining and slow convergence rate, these improved algorithms still need to be improved (Zhou et al. 2011; Tian et al. 2011; Sun and Lu 2010; Coelho 2010).

In this paper, chaotic simulated annealing quantum-behaved particle swarm optimization is presented to improve the performance of the algorithm. Chaotic state is a more general phenomenon of nonlinear systems, chaotic motion does not repeat itself to traverse all of the states according to the "law" within a certain range, as well as pseudo-randomness and chaos ergodicity can effectively improve the convergence rate. Simulated annealing algorithm is an optimization algorithm based on probability distribution mechanism, In the process of search, the algorithm has the features of time-varying and the probability sudden jump that finally tends to 0, which can effectively avoid falling into local optimal value and ultimately tend to the global optimal value. Automatic attenuation coefficient and temperature initialization based on the reception probability play an important role in the annealing process, which improve the probability to the optimal solution and speed of search, and solves the problems of slow convergence speed at search later period. In order to verify the good performance of this algorithm, the algorithm is used to solve the job shop scheduling problem.

2 Chaotic Simulated Annealing Quantum-Behaved Particle Swarm Optimization

2.1 Quantum Particle Swarm Optimization

In 2004, after studying Clerc and other scholars' research papers about the convergence behavior of the particles, from the perspective of quantum mechanics, quantum particle swarm optimization algorithm was presented by Sun. the algorithm makes full use of quantum state superposition, coherence and entanglement properties, and its state space is much larger than the linear system, this all make the algorithm search space is growing exponentially, so the algorithm can search the greater state space. Quantum particle swarm optimization algorithm describes the state of particles through the wave function $|\psi|$(x,t), and particle space probability density function of is obtained by solving the Schrodinger equation, by Monte Carlo method, to convert quantum state to normal state. The update equations of particles are as follows:

$$P_{ij}(t) = \varphi_{ij} P_{best_{ij}}(t) + \left(1 - \varphi_{ij}\right) P_{gbest_{ij}}(t) \tag{1}$$

$$x_{ij}(t+1) = P_{ij}(t) \pm \beta \left|P_{ij}(t) - x_{ij}(t)\right| \ln\left(1/\mu_{ij}\right) \tag{2}$$

Sun et al. (2006) presents the concept of average optimal position M_{best}, This variable represents the geometric center of particle swarm best position $P_{best_i} = \left[P_{best_{i,1}}, P_{best_{i,2}} \ldots, P_{best_{i,n}}\right]$, $(i = 1, 2, \ldots, M)$ at the current moment.

Defined as:

$$\begin{aligned} M_{best} &= [M_{best,1}, \ldots, M_{best,n}] \\ &= \left[\frac{1}{M}\sum_{i=1}^{M} M_{best_{i,1}}, \ldots, \frac{1}{M}\sum_{i=1}^{M} M_{best_{i,n}}\right] \end{aligned} \tag{3}$$

Thus, the particle location updates and transforms formula

$$x_{ij}(t+1) = P_{ij}(t) \pm \beta \left|M_{best,j}(t) - x_{ij}(t)\right| \ln\left(1/\mu_{ij}\right) \tag{4}$$

Where: parameter φ_{ij} is (0, 1) uniformly distributed random number; n is dimension of the particle; M is the number of particles; β is scaling factor, speed of convergence of the algorithm can be controlled by adjusting β. It can be determined by the following formula:

$$\beta = (\beta_1 - \beta_2) \times \frac{MaxIter - t}{MaxIter} + \beta_2 \tag{5}$$

Where: parameter β_1 and β_2 represent the initial parameter values and end values of β; t is the current evolution algebra; *MaxIter* is the greatest evolution algebra. Experiments show that β has good performances when it is changed from 1.0 to 0.5 at the end. $\pm$ is determined by the random number between the (0, 1). The algorithm is described as follows:

Initialization $i = 1$ to M

$IF \quad f\,(x_{\mathrm{i}}\,(\mathrm{t})) < f\,(P_{best_i}\,(\mathrm{t}))$, then $P_{best_i}\,(\mathrm{t}) = x_{\mathrm{i}}\,(\mathrm{t})$

$$P_{gbest_{ij}}(t) = \min \quad P_{best_i}\,(\mathrm{t})$$

Calculate M_{best}

For N = 1 to n

If rand (0, 1) > 0.5

$$x_{ij}\,(t+1) = P_{ij}(t) + \beta \left| M_{best,j}\,(t) - x_{ij}(t) \right| \ln \left(1/\mu_{ij} \right)$$

Else

$$x_{ij}\,(t+1) = P_{ij}(t) - \beta \left| M_{best,j}\,(t) - x_{ij}(t) \right| \ln \left(1/\mu_{ij} \right)$$

2.2 Particle Position Chaotic Initialization

The method of using chaotic sequences to initialize the particle positions does not change the algorithm stochastic nature, but also improve the diversity of population and particle search ergodicity of particles. This article, Logistic chaotic map is presented.

$$\lambda_j\,(t+1) = \alpha \times \lambda_j\,(t) \times \left(1.0 - \lambda_j\,(t)\right), j = 1, 2, \ldots, n \tag{6}$$

Where: after the t-th step evolution, $\lambda_j(t)$ stands for the value of chaotic variables λ_j which is the j-th variable. $\lambda_j \in [0,1.0]$, $1 \le \alpha \le 4$. When $\alpha = 4$ and λ_j is not equal to 0.25, 0.5, 0.75, the system shows complete chaos, chaotic sequence shows good randomness, and chaos variable trajectory can traverse the entire search space. Process is as follows:

$$\lambda_j\,(t) = \frac{P_j\,(t) - P_{\min,j}}{P_{\max,j} - P_{\min,j}} \tag{7}$$

$P_{\min,j}$ and $P_{\max,j}$ are the lower and upper bounds of the j-th dimension component. According to the formula (6), the next generation chaotic variable $\lambda_j(t+1)$ can be achieved. According to the formula (8), the chaotic variable can be converted into the decision variable $P_j(t+1)$.

$$P_j\,(t+1) = P_{\min,j} + \lambda_j\,(t+1) \times \left(P_{\max,j} - P_{\min,j}\right) \tag{8}$$

2.3 The Initial Temperature Value Set

Initial temperature value is one of the important parameters of simulated annealing algorithm, which affects the global search performance, a higher initial temperature, the global search ability is stronger, the optimization process time is longer; On the other hand, the search time is saved, but we can't find the global optimal values. Therefore, this article uses the temperature initialization method based on fitness and the accept probability, the initial temperature T_0 is determined by formula (9):

$$T_0 = \frac{\left(f_{\min}^0 - f_{\max}^0\right)}{\ln\left(p_r\right)} = -\frac{|\Delta f|}{\ln P_r}. \tag{9}$$

Where, f_{min}^0 and f_{max}^0 denote the smallest and the maximum value of the objective function, $|\Delta f|$ denotes the difference between the above two objective function. p_r means the initial acceptance probability, which is in the range [0.7, 0.9].

2.4 The Annealing Speed

The global search performance of simulated annealing algorithm is affected by annealing speed. Fixed temperature decay function can't adjust its local search depth dynamically according to the current convergence states. Therefore, this article introduces dynamic temperature decay coefficient, which can dynamic adjust temperature damping rate according to the current convergence condition, make the algorithm can adaptively change the depth of the local search, and adjust the population diversity. The adaptive temperature decay coefficient calculation formula is as follows:

$$\xi = \mu + \left[1 - \exp\left(f_{pi} - f_{avg}\right)\right] \times N\,(0,1)\,/2T_k \tag{10}$$

Where, f_{avg} is the population average objective function value; f_{pi} is the objective function value of the current particle best position; μ is the initial temperature attenuation coefficient; N(0,1) is random number that follows Gaussian distribution with mean zero and variance of 1. T_k is the temperature of particles in former iteration.

3 Job Shop Scheduling Based on Chaotic Simulated Annealing Quantum-Behaved Particle Swarm Optimization

3.1 The Algorithm Flow

1. Initialize each particle. Sets M, the number of particles, randomly generates a population including M particles; Sets scaling factor with the initial value $\beta_1 = 1$ and the end value β_2 =0.5; Generates the initial acceptance probability p_r.
2. Calculate the fitness of each particle; Initialize the annealing temperature $T_0 = (f^0_{min} - f^0_{max})/\ln(p_r) = -|\Delta f|/\ln P_r$.
3. Use each particle's fitness value to initialize its own best location P_{best_i}, and use the smallest fitness particles within the initial population to initialize the global best position P_{gbest_i}.
4. Judge whether the algorithm termination condition is reached. If so, then output the results; if not, then cycle, cycle control parameters k changes from 1 to M.
5. Calculate the average value M_{best} of each individual best position in the population by the formula (3).
6. Calculate the current position of the next generation particle by the formula (4)
7. Implement particle position chaos initialization transform by the formula (7) and (8), and update the next generation particle position.
8. Calculate each particle's fitness $f_i(k)$ and average fitness $favg_i(k)$.
9. If the current fitness of particle is better than the individual extremum P_{best_i}, then set P_{best_i} as the current fitness, selection optimal value from the individual extremum as a group extreme P_{gbest_i}.
10. Randomly generate a new position of the particle, calculate fitness $f_i(k+1)$ of each new particle and average fitness $favg_i(k+1)$.
11. Calculate the variation of fitness $\Delta f = f_i(k+1) - f_i(k)$ caused by two positions. If $\Delta f < 0$, accept the new position; If $\exp(-\Delta f/T) > rand$, Also accept the new position, otherwise keep the old location.
12. According to individual fitness and average fitness, calculate the automatic temperature attenuation coefficient ζ.
13. $T_{k+1} = \zeta T_k$, $k = k+1$, where $\zeta \in (0,1)$, to 4).

4 Discussion

To validate performance of the proposed chaotic simulated annealing quantum-behaved particle swarm optimization algorithm for solving job shop scheduling problem, this experiment takes the FT standard scheduling problem such as FT06 and FT10 and FT20 for example, to minimize makespan as the goal, the coding method based on process, compare the SAQPSO algorithm performance with GA, PSO, and QPSO. Experiment hardware environment is the Pentium 4, CPU frequency of 2.71 GHz and 1.75 GB of memory. The simulation software is Matlab7.0. Algorithm parameter settings are as follows: the cross probability of GA is Pc = 0.9, mutation probability Pm = 0.1; the acceleration constant of PSO algorithm $c_1 = c_2 = 2$, inertia weight w is 0.8; the scaling factor β of SAQPSO and QPSO algorithm linearly reduces from 1.0 to 0.5; temperature attenuation coefficient of SAQPSO is 0.98, the initial acceptance probability $P_r = 0.7$; population size is 100, the iterations times is 200, each FT standard scheduling test run 20 times independently. The algorithm test results are shown in Table 1.

Where, $\min V$, $AveV$ and $AveT$ are the minimum, average, and average convergence time (s).

From Table 1, for the FT06 problem, all algorithms can converge to the optimal solution, quantum particle swarm used shortest time; For FT10 problem, only QPSO and SAQPSO two algorithms converge to the optimal solution, and SAQPSO used the shortest time; for FT20 problem, only SAQPSO algorithm converges to the optimal solution, as compared with other algorithms, $AveV$ is the minimum value during 20 times operations, the $AveT$ is slightly longer than GA. Therefore, from the experimental data, we can conclude that SAQPSO algorithm optimization ability is stronger than another several other algorithms, especially with the problem size increasing, performance optimization is more obvious.

5 Conclusion

In order to solve the premature convergence problem of Quantum-behaved Particle Swarm Optimization (QPSO), this paper uses the randomness and ergodicity of chaotic search to initialize the population; uses jumping ability of the simulated

Table 1 Optimal results comparison of various algorithms in 20 experiments

Problems		FT06	FT10	FT20
Scale		6×6	10×10	20×5
C^*		55	930	1,165
GA	$MinV$	55	970	1,180
	$AveV$	55	990	1,200
	$AveT$	19	229	279
PSO	$MinV$	55	949	1,189
	$AveV$	55	969.8	1,199
	$AveT$	45	416	467
QPSO	$MinV$	55	930	1,170
	$AveV$	55	965	1,189
	$AveT$	17	233	419
SAQPSO	$MinV$	55	930	1,165
	$AveV$	55	937	1,170
	$AveT$	23	177	320

annealing algorithm to Prevent the algorithm from falling into local optimum; uses adaptive temperature adjustment coefficient to percept algorithm search process of real-time and adjust the search strategy. The algorithm is better to balance the global and local searching ability, improves the algorithm performance, the standard workshop scheduling simulation results indicate that the proposed algorithm performances are improved obviously than other algorithms. For chaotic simulated annealing quantum particle swarm algorithm, further theoretical analysis and improvement, using it to solve actual engineering problem, and expanding its application scope, which will be our next research content.

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